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Where You Turn

Working with

Condmaster®Nova

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Contents

Task Definition

Machine faults, condensate pump 1
Machine data, condensate pump 2

Graphical Overview

Graphical Overview 3
Your own pictures in the Graphical Overview..... 4
Import picture 5
Arrange your folders on the pictures 6
The tree structure 7
Creating elements in the tree structure 8
Components and measuring points 9

Components

Creating a component..... 10
The component form..... 11
Extended component form..... 12
Copy component 13

Measuring points

Creating a measuring point..... 14
Copy measuring point 15
Measuring Point Data 16
Edit copy of measuring point..... 17
Basic data and measuring techniques 18
Dual shock pulse measurement techniques..... 19
Multiple measuring devices on one assignment 19
General RPM settings for the measuring point 20
Storage information in Measuring point data..... 21

Measuring Techniques

Input data for SPM dBm/dBc 22
Input data for SPM LR/HR 23
SPM LR/HR, connection to Lubmaster 24
Using the bearing catalogue..... 25
Overview of assignments 26
Overview, edit symptoms..... 27
Overview, alarm limits and alarm delay..... 28
SPM Spectrum, input data 29
SPM Spectrum, advanced settings..... 30
Bearing symptom parameters..... 31
Selection of rotating bearing part 32
SPM Spectrum, highlighted symptoms..... 33
The SPM HD measuring technique 34
SPM HD, input data 35
ISO 2372, input data 36
ISO 10816, input data 37
ISO 10816, spectrums..... 40
EVAM assignments, input data..... 41
EVAM: Saving data in short and long time memory 42
EVAM: Frequency range settings 43
EVAM: Assignment for analysis 44
Frequency range for EVAM: Shaft symptoms..... 45
Frequency range for EVAM: motor, pump..... 46
EVAM: FFT type and averaging for Machine Evaluator and OIS 47
EVAM: Assignment for enveloping..... 48
EVAM: True Zoom settings 49
EVAM: All condition parameters..... 50
EVAM: Add symptoms and symptom groups 51
EVAM: Disable excessive data 52
EVAM: Configure symptom, set alarm limit..... 53
EVAM: Settings for Machine Evaluator display..... 54
Input data for user defined measurement 55
Input data for temperature measurement 56
Checkpoint and comments download 57
Input data for lubrication round..... 58
Orbit analysis..... 59
Orbit analysis, input data 60
Viewing Orbit measurement results 61
Two channel simultaneous vibration measurement 62
Input data for two channel vibration measurement..... 63
Bump Test..... 64
Run Up and Coast Down measurements 65
Working with the Run Up and Coast Down results 66
Measuring techniques in the tree structure..... 67

Measuring Point Tree

Making your own folder 68
Copy alias via clipboard to folder 69
Copying in round order..... 70
Working with a split window 71
Working inside your own folders 72

Measuring Rounds

Creating a measuring round 73
Entering measuring points into a round..... 74
Download round to instrument..... 75
Connecting the Machine Evaluator to a PC..... 76

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Where You Turn

Connecting Machine Tester to PC 77
Uploading results to the PC, closing the round 78
Identification tag CondID™ in Condmaster 79

Status Display

Status display in the Graphical Overview 80
Status display for measuring techniques 81

Evaluation Functions

Evaluation functions from the Overview 82
Alarm list 83
Working with the alarm list 84
Alarm type 85
Flexible alarm limits 87
Bands 88
Alarm delay 92
Measuring result register 93
Measuring results for EVAM 94
Spectrum and symptoms 95
Working with the spectrum 96
Compare spectrum 99
Selecting measuring points for Compare Spectrum 100
Working with Compare spectrum 101
Reference spectrum 102
Pattern recognition in an SPM Spectrum 103
Waterfall diagram 105
Order tracking 105
Colored Spectrum Overview 107
Evaluating two-channel measurement results 111

EVAM Evaluation

The evaluation of EVAM readings 114
COND numbers in graphics and spectrum 115
Recording a batch of EVAM readings for the Machine Evaluator 116
Recording a batch of EVAM readings for Machine Tester 117
Applications for the Machine Evaluator recording function 118
The Condition Manager 119
Creating and editing criteria 122
Display of evaluated EVAM results 125
Criteria with different selection conditions 126
The effect on COND numbers 127
Measuring result list in graphs 128
Display of COND no. and raw value 129
The Crest factor 130
Kurtosis 130
Skewness 131
Unbalance 131
Misalignment 132
Looseness 132
VEL, CREST and KURT 133
Checking the spectrum 134
Spectrum with logarithmic Y-scale 135

Comments

Working with comments 136
New / edit comments 137
Download comments to instrument 138
Set a comment in the Graphic Evaluation 139
Comment with additional text 140
Comments in the Graphic Evaluation 141

Graphics Functions

Graphics functions in Condmaster Nova 142
Selection of items for graphics display 143
The display of diagrams 144
Selection of measuring techniques 145
Elements of a diagram 146
Display of moving average 147
Combining two diagrams 148
Comment and measuring result tables 149
Editing and adding comments 150
Text above and below a diagram 151
Saving standard texts 152
Printing diagrams 153
Popup menus for EVAM points and alarm 154
Zoom Properties 155
Drivers for screen and printer 156
Logotype on screen and printouts 157
Connecting drivers with screen and printers 158
Creating new moving average 159

Lubmaster

Lubmaster 160
The evaluation graph 161
Bearing condition development 162

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Measuring point calibration 163
Lubrication data for COMP no. calculation 164
Calculation of alarm limits 165
The lifetime graph 166
Selecting the optimal lubricant 167

Work Orders

Standard work order for working mode "Planning" 168
Compiling a standard work order 169
Compiling work orders 170
Editing work orders 171
Executing work orders 172
Preset speed in work orders 173

OIS Functions

OIS functionality 174
Triggered measurements in the Commander Unit 177
Filtering of measurement results in LinX 178
Graphical filtering in Condmaster 179
Run up / Coast down measurement 182
Multiple SPM Spectrum assignments 182
Monitoring unit workload 184
Machine operating conditions 185
Setting graphical filters for machine operating conditions 187

Additional functions

Rule Based Evaluation, RBE 188
Work descriptions 189
Standard symptoms for EVAM 190
Symptom groups 191
Report Manager 192
Export to Word file 196
Export of measuring results to Excel 196
CondmasterWEB 197
Runtime count 198
Plant Performer™ 200
Economical statistics 200
Corrective maintenance comments 201
Communication with SAP software 202
Safety copy 203

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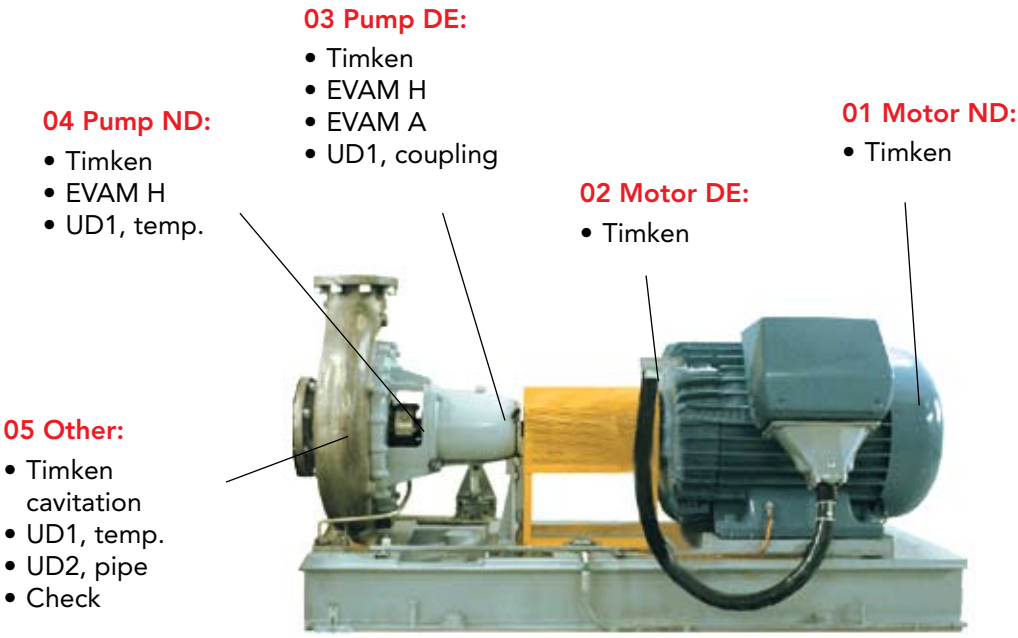

Measuring techniques on condensate pump

Machine faults, condensate pump

The following pages show how to set up Condmaster Nova for a measuring round, containing two condensate pumps and two heating water pumps, identical pairs, and their measuring points, using all available measuring techniques.

Before you input data into Condmaster Nova, you have to consider what kind of machine faults you are looking for. For the first example, the main condensate pump in a heating plant, these are assumed to be:

- Bearing damage, motor and pump bearings
- Pump vibration, general and at selected frequencies
- Misalignment between motor and pump
- Loose foundation bolts, other looseness
- Impeller damage

Pump cavitation

- High temperature on the non-drive pump bearing
- Coupling wear
- Pipe wear, outflow side 1st bend
- Pump seals and general condition of the pump location.

This fault list is the basis for the selection of measuring techniques, see the picture. The fault list is important, because unless you target specific faults, you do not know what to measure or cannot make sense of the measuring results.

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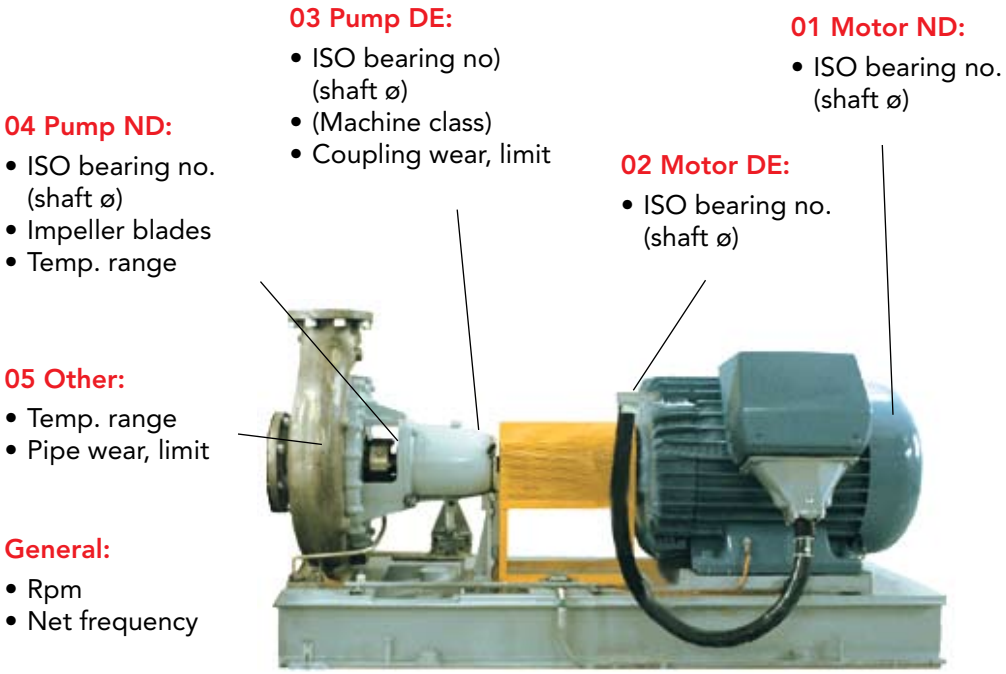

Machine data for input

Machine data, condensate pump

For the machine itself, you need the component data: machine number and name, location (option), and all other component data you want to register, see under "Extended component form" in chapter "Component data". You may also want to store pictures of the station where the pumps are located and of each pump type.

The machine data you need to set up the measuring points depend on the measuring techniques you intend to use. In this example, they are:

- the rpm of the machine (for Timken, EVAM).
- the ISO standard number of all monitored bearings (for SPM LR/HR, SPM Spectrum and EVAM). The ISO bearing number gives you access to the bearing catalogue data stored in Condmaster Nova, including the factors needed for a vibration spectrum analysis on bearings. For SPM dBm/dBc, the shaft diameter is sufficient bearing data.
- the number of impeller blades on the pump (for EVAM, symptom 50).
- the range of temperature measured on the pump housing.
- limit values for the coupling and pipe wear to be measured.

For an extensive vibration analysis of the motor you would need to know the number of poles, rotor bars, stator coils and, of course, the net frequency.

Measuring points are checked and marked beforehand. As measuring tools and inspection tools, use either of the portable instruments, a stroboscope lamp to check the coupling, and an ultra sound meter to measure the pipe wall.

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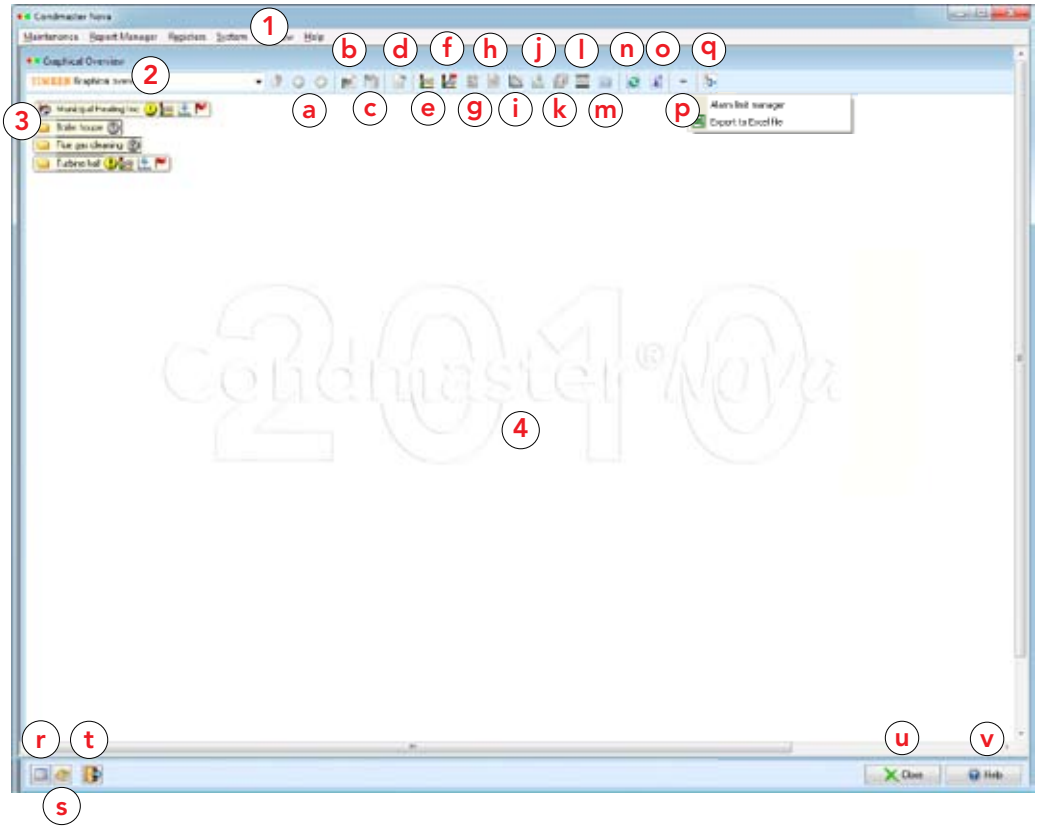

Graphical Overview

Condmaster Nova starts in the Graphical Overview. From this form you can reach all functions via drop down menus and direct access buttons. When the buttons are grey, they are not active, else they take you to the function for the marked folder or marked item inside a folder.

In Condmaster Nova, the overview has a standard layout, which you can change by importing your own pictures and arranging your machine and measuring point folders in the order you want.

1 Main functions, dropdown menus
2 Measuring point tree, pulldown
3 Main folder for components and measuring points
4 Background picture

Buttons:

a Browse the measuring point tree
b Go to Alarm list
c Delete alarm
d Edit marked item
e Go to Graphical Evaluation
f Go to Graphical Evaluation (only alarmed)
g Go to Measuring results
h Go to Comments
i Go to LUBMASTER
j Go to Spectrum / Compare spectrum
k Go to Waterfall diagram
l Go to Colored Spectrum Overview
m Go to Plant Performer
n Refresh screen
o Properties / Import picture
p Go to Alarm Limit Manager; Export to Excel file
q Toggle Graphic overview / Measuring point tree
r Go to Data transfer
s Search for help text
t Exit program
u Close window
v Show help text for this form

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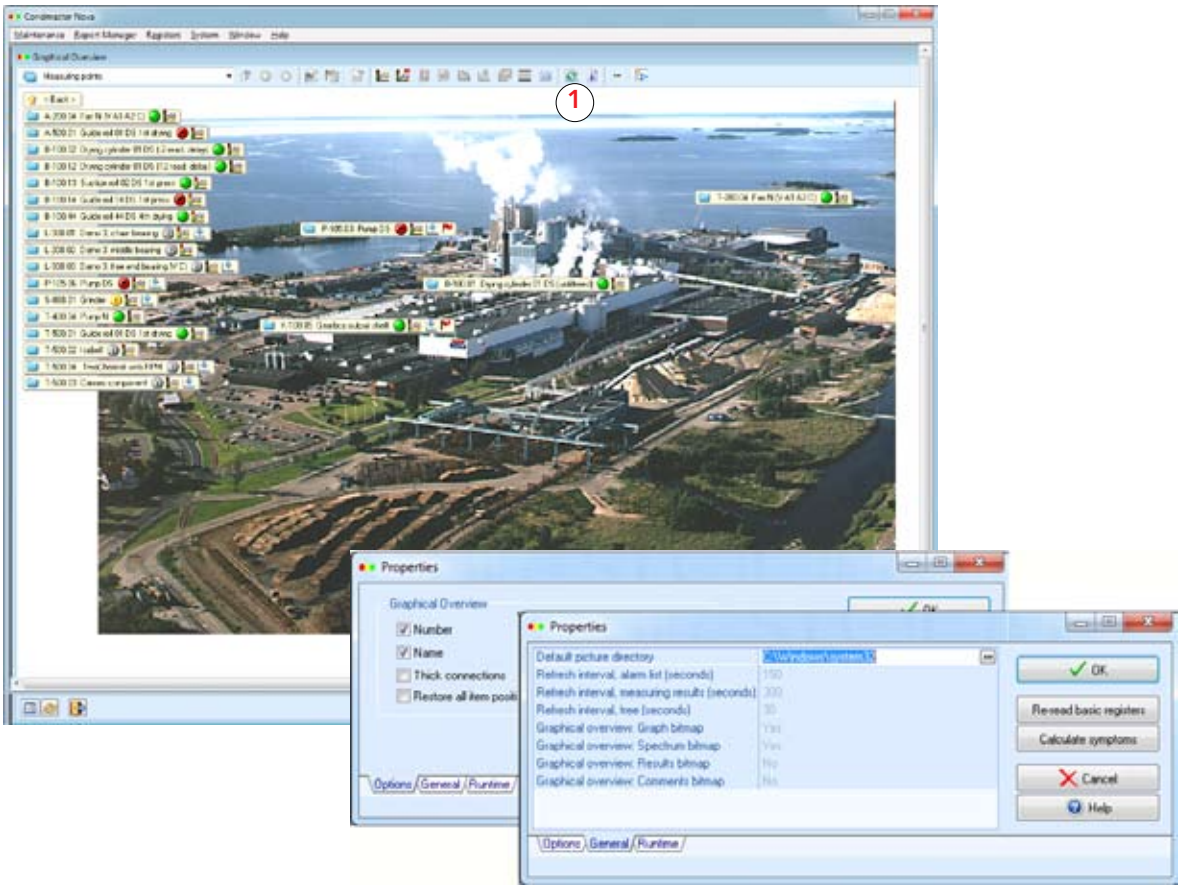

Your own pictures in the Graphical Overview

As an option, you can customize the Graphical Overview, using pictures of your plant and its sections, right down to machine and measuring point level. You can then drag your folders (components, measuring points) to any part of the picture, and also obtain a connecting line between a folder and a spot on the picture by dragging the status dot to this spot.

For each location (folder, component) in your tree structure, you can import one picture. The picture can be a photo, a floor plan, or a machine drawing. The only requirement is that you save it in .bmp or .jpg format, for instance with the program PAINT. You can store your pictures inside the Condmaster Nova folder or in any other convenient location.

Use the "**i**" button in the menu bar to open the **Properties** window and define options for measuring point display.

Thick connections under the **Properties** tab (1) allows you to select a thin or a thick line connecting the folder symbol with a dot placed somewhere in the picture.

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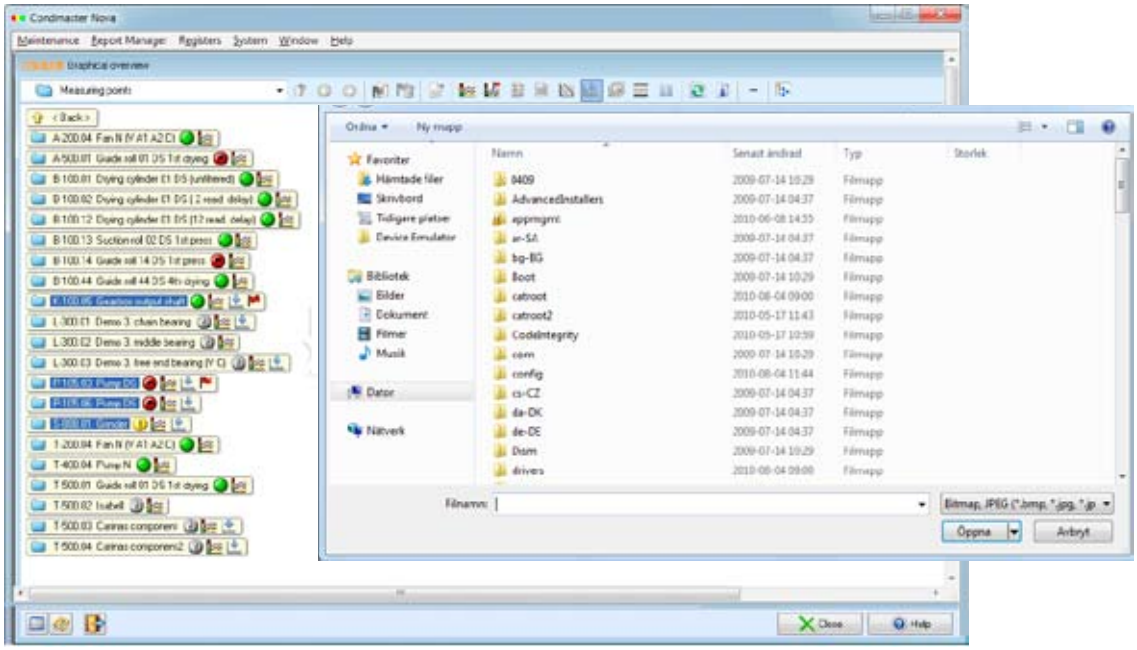

Import picture:

- Right hand click.
- Select **Add picture**
- Select picture via browser, then drag into place.
- Input display options under "**i**".

Import picture

To import a picture, go to the desired location in the Graphical Overview by clicking on the folders until you reach the level where you want to insert it. Right hand click in the window, select **Add picture**. A browser is displayed where you can go to the picture file and select it. When the picture is up, drag it to the desired place.

To move the picture at a later stage, right hand click in the picture to activate it.

The settings under "**i**" determine how many clickable links will be displayed on the measuring point tag, in addition to the status dot and the alarm flag.

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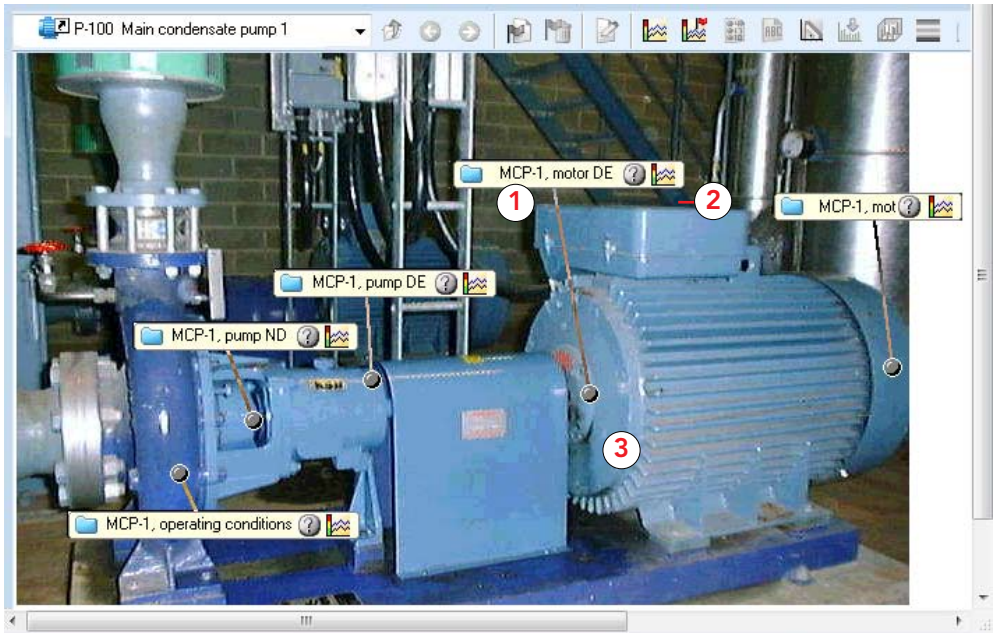

Arrange folders:

- Click on an item (1), drag it to the desired place.

Mark measuring point:

- Click on the status dot (2), drag the grey marker (3) to the desired place.

Arrange your folders on the pictures

Folders (1) can be dragged to any place on the picture. Click on the item, hold down the mouse button and drag. Similarly, you can create a grey marker (3) by dragging the status dot (2) to any desired spot. A line connects the grey marker and the box. To remove the marker, drag it inside the box.

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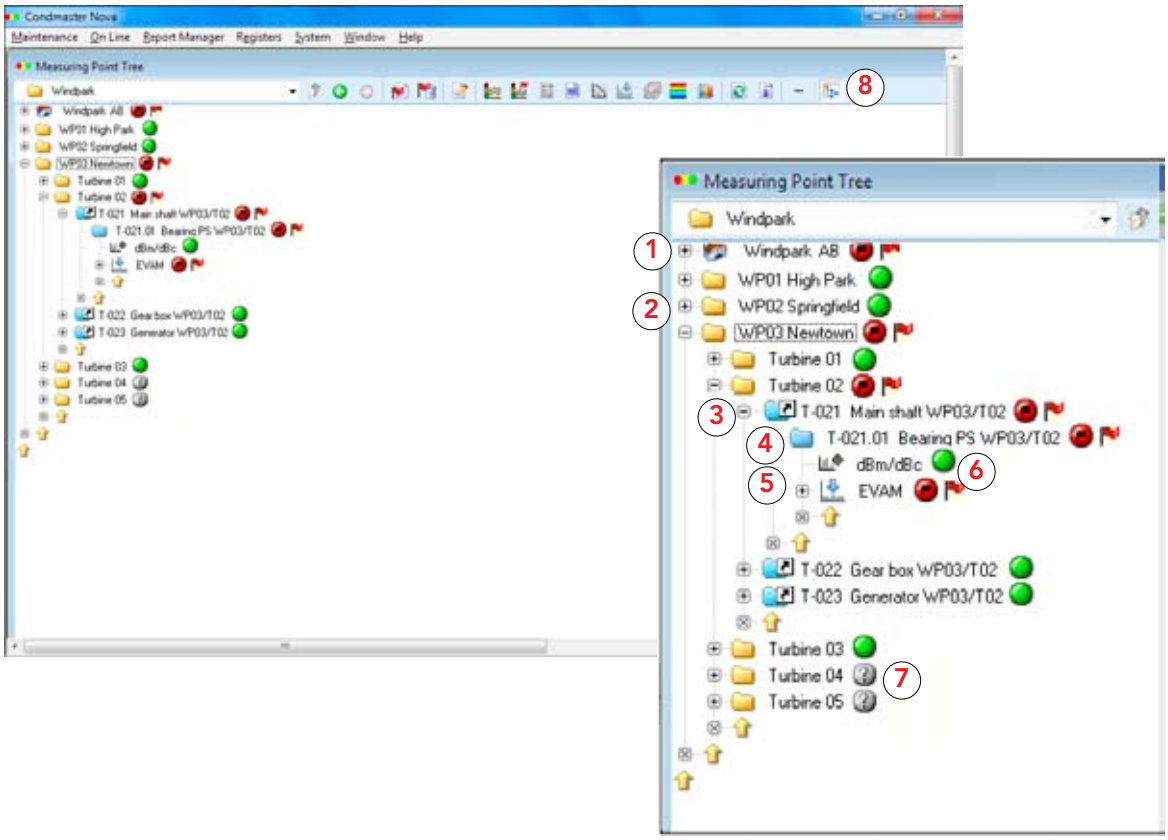

The tree structure

The tree structure in Condmaster is where you build the structure with the available elements, folders, components and measuring points, that fits your purpose best. It gives an excellent overview over the monitoring system.

The simplest structure is the main folder with the license name (1) which contains a measuring point folder with individual measuring points, see next page.

The example here shows a structure for three windparks (yellow folders named WP..., 2). The third folder is open and reveals a number of yellow turbine folders. The Turbine 02 folder is open and reveals three components (= machine units, blue motor symbol, 3): main shaft, gearbox and generator. The measuring point on the main shaft (blue folder, 4) reveals the two measuring techniques used (individual symbols, 5): dBm/dBc and EVAM.

There are two advantages with such a structure:

- Each element in the structure has its status symbol (green, yellow or red dot showing condition, alarm flag in case an alarm limit has been exceeded). This dot reflects the status of the lowest element in the structure. Here, all red dots with alarm flag are caused by an EVAM alarm on the main shaft bearing of turbine 02 in the third windpark.
- Folders can be copied with all subfolders, components and measuring points. In this case, a turbine folder would be the ideal element to copy. By editing component and measuring point names one can quickly create a 'new' turbine if it is constructed on the same lines.

Elements without evaluated measuring results have grey status dots (7). The button (8) toggles between Tree structure and Graphical overview.

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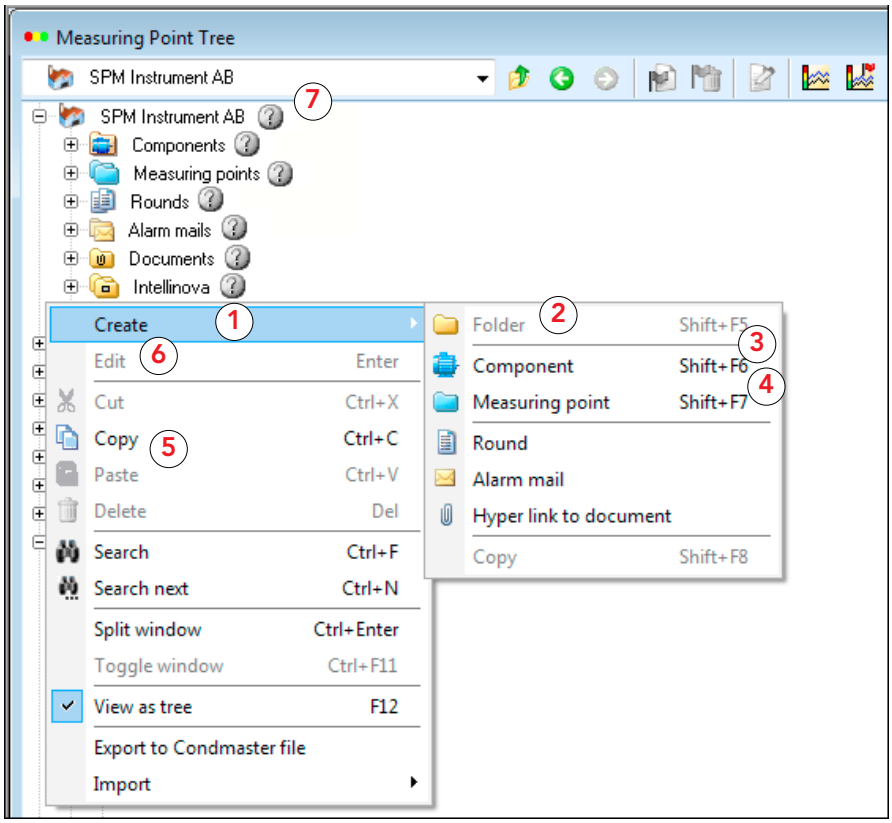

Creating elements in the tree structure

Right hand click anywhere in the Tree structure and select **Create** (1) to make any of these elements:

- folders (2),
- components (3) and
- measuring points (4)

Once an item is configured and saved, you can mark it and use **Copy** and **Paste** (5) to duplicate it, then **Edit** (6) to create a similar item.

Holding down CTRL while clicking on folders or components allows you to mark a entire group in any order. To mark a group of items, you can also click on the first, then hold down the SHIFT key and click on the last item in the group. You can freely drag items within the tree structure and also split the screen and drag them from one part to the other. You can also use **Cut** and **Paste** to move items to another position.

Please note that each item you create or paste is inserted **above** the marked position. Thus, if you mark a folder, the components in the clipboard will be pasted in outside of and above this folder. To get it inside, you must open the folder and mark the arrow beneath the last item or any of the items inside.

All *folders* you create are originals. The *originals of measuring points and components* are placed inside the *main folder* that has the license file name (7). The original measuring point and component folders are sorted alphabetically by number. To delete measuring points and component, you must deleted them from these original folders, else you only remove copies. Copies are marked with a bent arrow.

The folders inside the main folder are created automatically. There you will also find rounds and e-mail alarm assignments if you use these elements.

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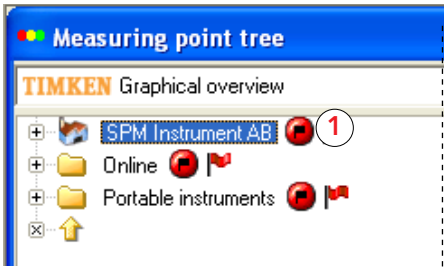
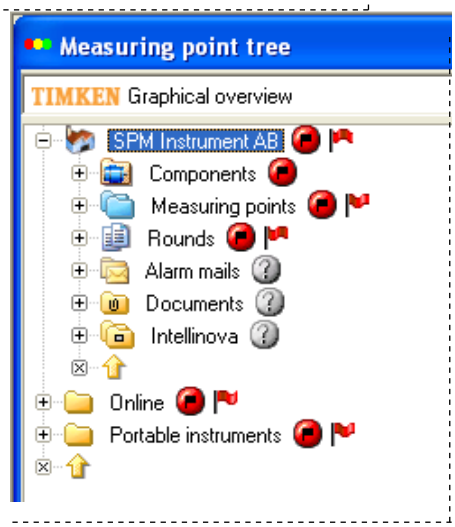


Basic tree structure:

Main folder (1).

Double click to open.



Folders with registers of

- Components
- Measuring points
- Rounds
- Alarm e-mails
- Documents

Double click to open.

Toggle between Graphical Overview and Measuring Point Tree

Components and measuring points

To create components and measuring points, you work in the Measuring point tree, which is reached by pressing the lower left hand button from the Graphical Overview.

At the top, the Measuring point tree contains a folder with the license name of your Condmaster Nova. This folder cannot be deleted. It contains the component register and the measuring point register, each in its permanent folder. These are empty when you start a new Condmaster Nova without demonstration data.

Beneath these three folders, your own tree structure can be created. There are two alternatives:

- Alternative 1: Create components and measuring points first, working in the register folders. These will be sorted alphabetically by number. Later, you can create your own structure of folders (this is an option) and drag aliases of your components and measuring points into them. The originals remain in the two register folders. This is the sequence described in this manual.
- Alternative 2: First create your own folders, and work inside your folders when creating components and measuring points. Inside your folders, they are aliases. The original will be automatically put into the register folders.

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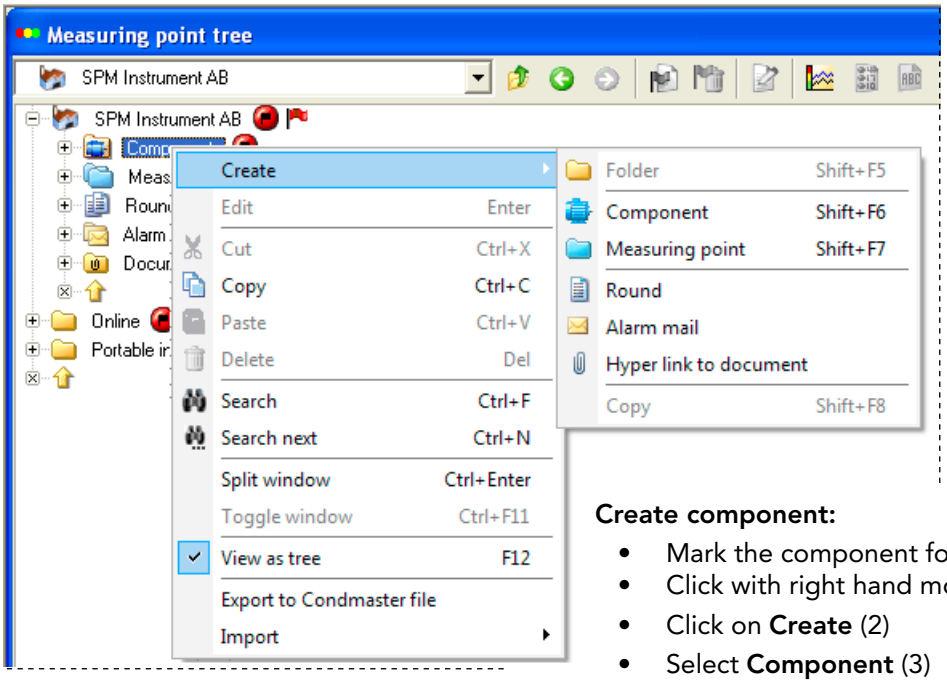

Create component:

- Mark the component folder (1)
- Click with right hand mouse button
- Click on **Create** (2)
- Select **Component** (3)

Short-cut: Mark the main folder, press F6

Creating a component

A component is a complete machine (in this example the main condensate pump including its motor) or a "manageable" section of a large machine (e. g. the press section of a paper machine). As far as possible, work with "complete" components, because the operating condition of one part, e. g. the motor, will affect the condition measurements on the whole machine.

Clicking with the right hand mouse button opens a menu with **Create** at the top. Click on that and select the item to create, here **Component**.

As a faster alternative, mark the component folder (or the closed main folder with the company name) and press F6.

Please note the importance of what item in the tree is marked when pressing the right hand mouse button (or F6). If the component folder (or the closed main folder) is marked, the component is created inside the component folder, as an original. If the space below is marked (as a rectangle with faint lines) or any of your own folders, an alias is created in that location, plus an original in the component folder.

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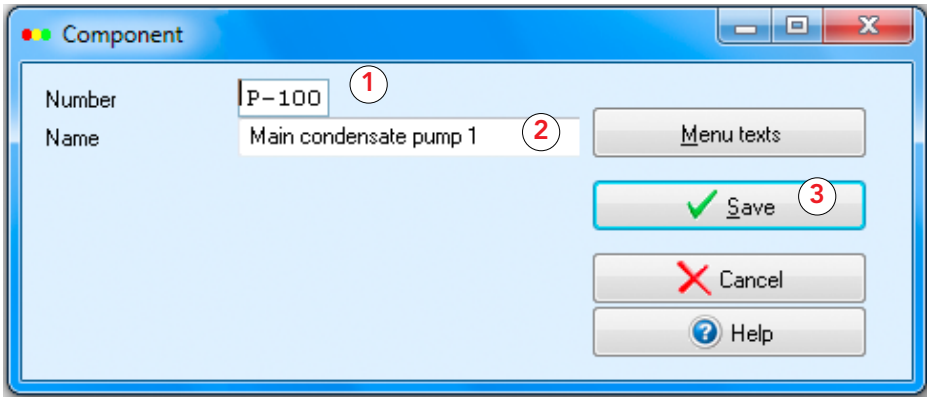

Standard component data:

- Enter component number (1) and name (2)
- Click **SAVE** (3)

You can use the TAB key to move to the next data field or button

The component form

The required input data for a component are number and name. You cannot save the item before the required data are input.

If at some later point you edit the original component number, Condmaster will ask if measuring point numbers belonging to the component should be automatically updated to reflect the change. This is normally recommended.

If you want to register additional component data, click **MENU TEXT** and modify the component form.

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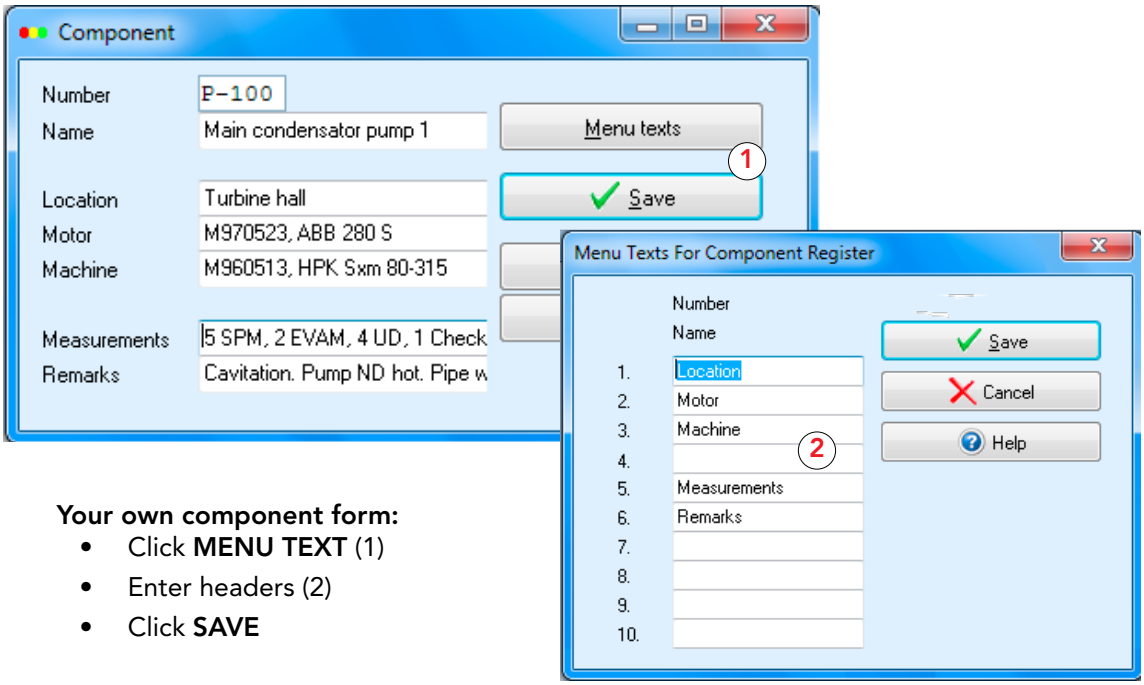

Your own component form:

- Click **MENU TEXT** (1)
- Enter headers (2)
- Click **SAVE**

Extended component form

Up to 20 lines of component data can be entered. An additional line is activated when you type a header on that line, on the form **Menu text**.

Entering the additional data when creating a new component is an option: you can save the component after entering no more than number and name.

If you modify the component form at a later stage, e. g. by erasing a header, you will not erase the data on such a line. It will be invisible until you reactivate the line.

Please note: the reports used to print component data on screen or paper are not linked to the menu text form. They have to be edited to fit your own form, using the report generator under the main function **Printout**, found in the menu bar.

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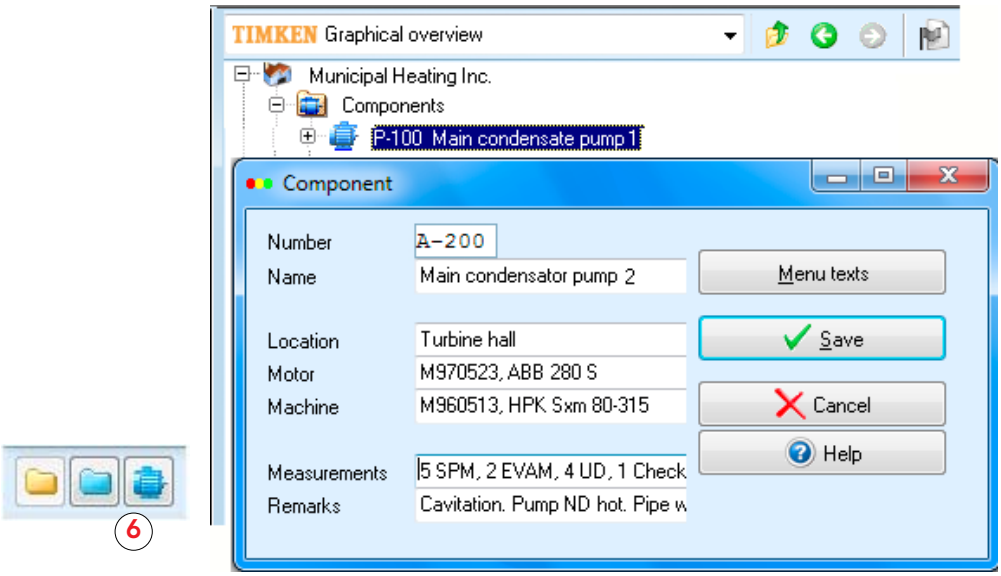

Copy component:

- Mark component, press F8 (1) or click the component symbol (6).
- Edit component number and name (2).
- If required, edit component and measuring point data (3).
- Click SAVE (4).

Copy component

Quite often, you will have a number of identical machines, measured in the same way and with little or no difference in the input data. Once the first of these machines is in the Condmaster Nova data base, you can copy it and quickly create new components, changing only component number and name.

You should, however, verify the machines' technical data, especially when you use SPM Spectrum or EVAM for bearing condition analysis. For a spectrum analysis, the exact bearing geometry can be very important.

In our example, we have a pump station with two pairs of identical pumps. For each twin, only component number and name have to be edited on the component copy (and the serial numbers, if recorded). A copy becomes a new component when the component number is changed. The measuring point numbers are changed automatically, because the new component number becomes a part of all measuring point numbers. In this example, the measuring point names have to be changed. This is not necessary when you use "neutral" names.

A component (measuring point) number is edited by placing the cursor in front of the part to be changed and overwriting the following position(s): P-10|0 –> P-101 when you type 1 with the cursor before the last 0. To change names, right hand click in the name field to get the edit functions, or just mark the text and overwrite it.

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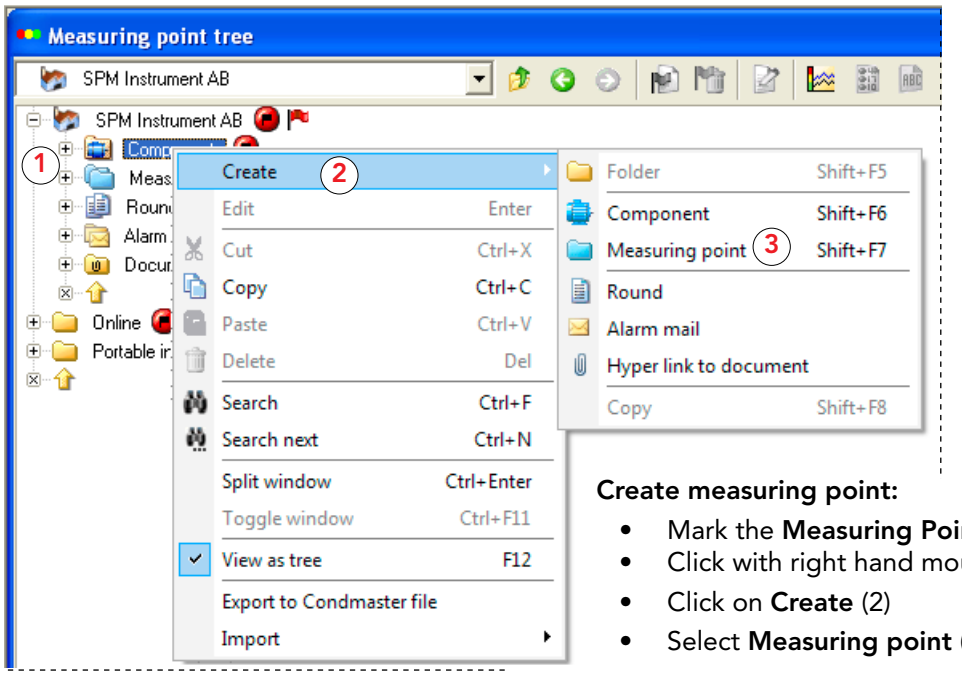

Create measuring point:

- Mark the **Measuring Points** folder (1)
- Click with right hand mouse button
- Click on **Create** (2)
- Select **Measuring point** (3)

Short-cut: Mark the measuring point folder, press F7

Creating a measuring point

In Condmaster Nova, the measuring point is a purely administrative item. Thus, a Condmaster Nova measuring point can represent several physical measuring points in approximately the same location on the machine, where you collect different sets of data with different transducers connected to the portable instruments, or even use other measuring instruments.

Measuring points can stand by themselves, unconnected to a component, but normally they are attached to components. They are always automatically stored in the standard folder "Measuring points", whose properties correspond to those of the component folder. In addition, they are listed below the component icon when created as part of the component.

To add measuring points to a component, first mark this component in the measuring point tree. Clicking with the right hand mouse button opens the menu with **Create** at the top. Click on **Create**, then on **Measuring point**.

As a faster alternative, mark the component (alternatively the measuring point folder or the closed main folder with the company name) and press F7.

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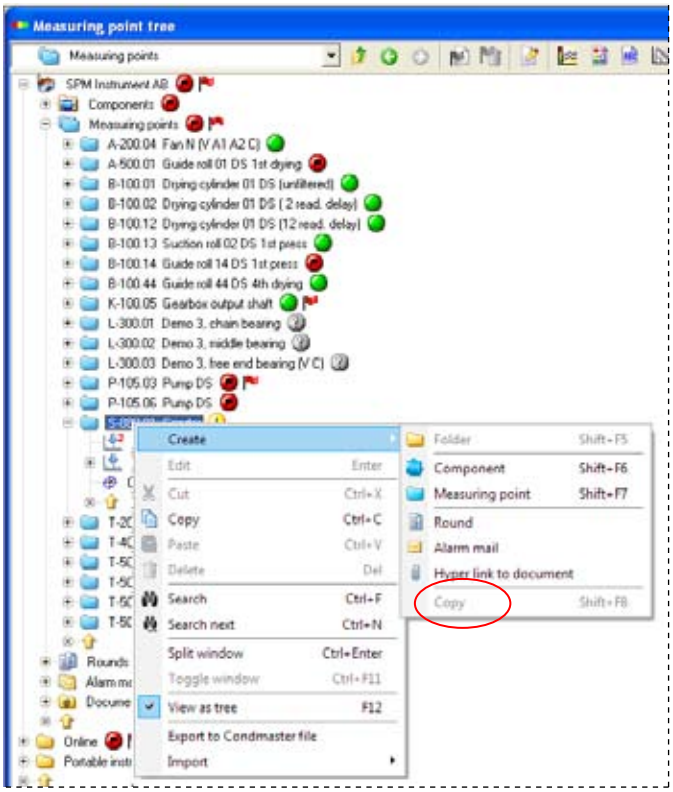

Copy measuring point:

Mark a measuring point, then either

- right click on the point and select **Create/Copy**, or
- press F8, or
- click the **Create - Copy (measuring point)** button in the lower left hand corner of the screen

Copy measuring point

The fastest way to create a measuring point is to copy an existing point. You can mark the measuring point to be copied, click with the right hand mouse button, then select **Create** and **Copy**.

The shortcut is to mark the point and press F8. Another alternative is to mark the point and click the **Create - Copy (measuring point)** button in the lower left hand corner of the screen.

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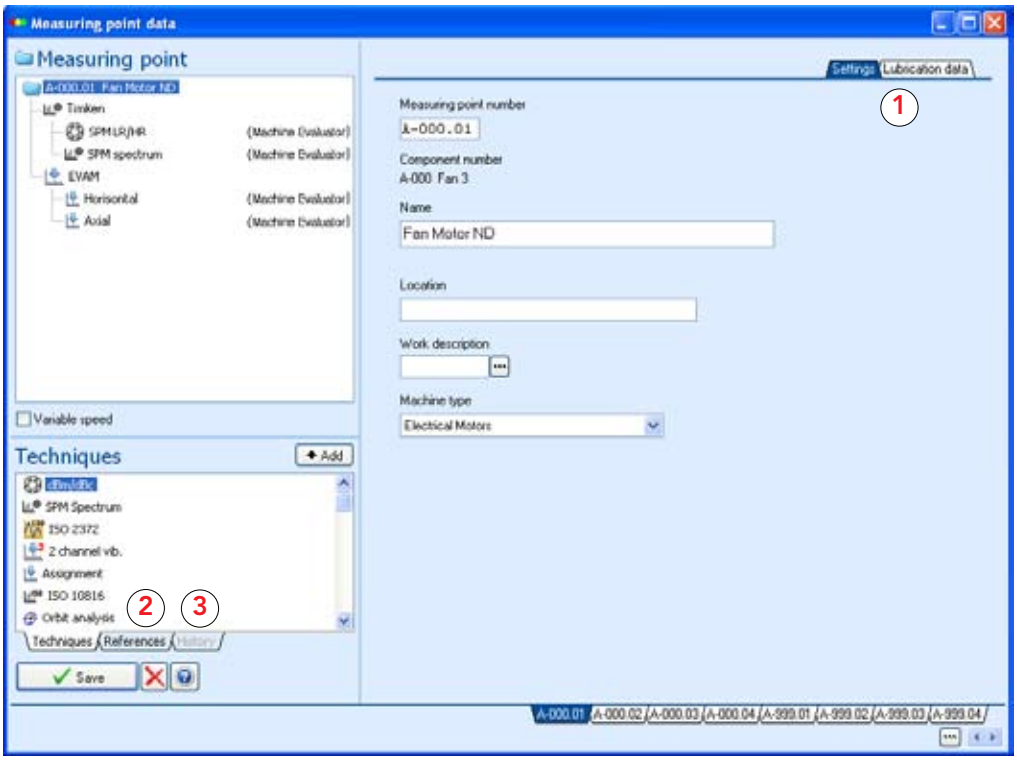

Measuring Point Data

In the upper right corner of the **Measuring Point Data** form you'll find tabs for **Settings** and for further settings that are measuring device dependent (1). In the lower left corner of the form are two tabs, **References** and **History**:

References

References (2) is best described as a way to create templates for entire measuring points, or parts thereof. Let's say you have a large number of measuring points, using the same or very similar transducers, bearings, measuring techniques, settings etc. You can then create a "template point" with your default settings and right click in the **Measuring Point Data** form to save it as a reference:

- Right click on the measuring point level to save the *entire measuring point* as a reference, including frequency range, symptoms, resolution etc.
- Right click on the technique level to save all settings for the *technique* as a reference
- Right click on a measuring assignment to create a reference on *assignment* level. These references will also show up in the vibration guide for the instrument(s) active on the assignment.

Now create your new measuring points and select your new reference from the **Reference** tab to automatically configure them with the settings from the reference. Essentially, this could be compared to copying a measuring point, but using the **Reference** option is quicker because you don't have to search the measuring point register for the measuring point to copy.

History

History (3) provides a log of all changes made to a measuring point or assignment. Once the change has been saved, the previous settings can be viewed on the **History** tab. This makes it easy to e.g. manually restore a previous setting on an individual measuring point, without having to load a backup copy of the entire database.

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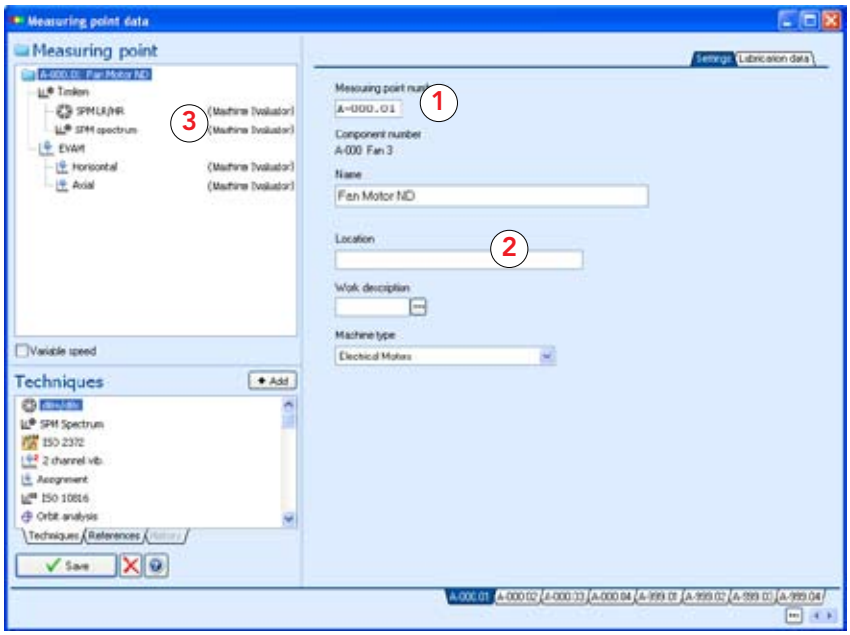

Edit copy of measuring point:

- Edit measuring point number (1) , name (2) if required
- Select measuring techniques (3) if required

Edit copy of measuring point

To turn a copy into a new measuring point, the measuring point number has to be changed. The next free number belonging to the component is automatically input. Of course you also edit other data as required.

In this example, the name has been changed to "Pump DE" (drive end). More measuring techniques have been activated. Their data input forms are shown when you drag them into the upper field. You can input the data at once or after selecting all techniques. Click on the technique to display the form.

As a rule, *use measuring points with the same or fewer measuring techniques* when making copies. When you deselect a measuring technique that has been configured before, you do not delete the data on the technique forms, you only hide them. They turn up again when you activate the technique.

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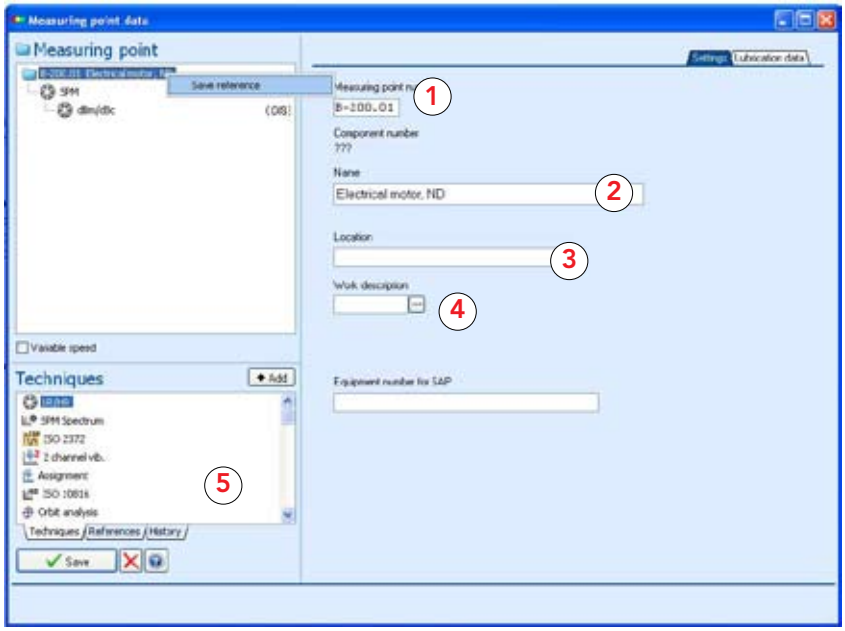

Measuring point:

- Input number (1) and name (2). Location (3) and work description (4) are options.
- Drag measuring techniques (5) to the upper window, or double click on them.

Basic data and measuring techniques

Compulsory input for measuring points are number (1) and name (2). When the measuring point is created as part of a component, the measuring point number is automatically set to the next free number under this component. Thin, vertical lines underneath the **Name** field mark line breaks in the Machine Tester display. For best readability, adjust long names so that there is no line break in the middle of a word. While your cursor is inside the name field, you can right hand click to obtain a list of edit functions (3) for the text in this field.

The location information is an option, normally you use measuring point names which describe the location, e.g. "Motor ND" (non-drive side).

Work description is an option – see section "Work descriptions" in the "Additional Functions" chapter. A work description attached to a measuring point will turn up on measuring rounds and/or work orders and can be printed when downloading to the instruments.

The available measuring techniques are shown in the bottom left hand field. Select one (or more) of the measuring techniques by double clicking or by dragging it to the upper field. Depending on the shock pulse technique activated in your instrument, select **SPM dBm/dBc** or **SPM HR/LR** for shock pulse measurement. The measuring techniques Run up/Coast down and Bump test are not on the list **Available techniques** - if you wish to use them, activate them in the Machine Evaluator . When you upload your measuring round to the PC, the Run up/Coast down and Bump test results can be viewed under **Comments** for the measuring point in question.

When no default instrument has been set for the measuring technique under **Measuring system** (see under header "Measuring system, selection" in the "General Setup" chapter), a form for selecting the instrument is shown when setting up the measuring point. To change instrument, right hand click on the technique.

For each selected technique, a data form is opened in the right hand field where you input the measuring parameters.

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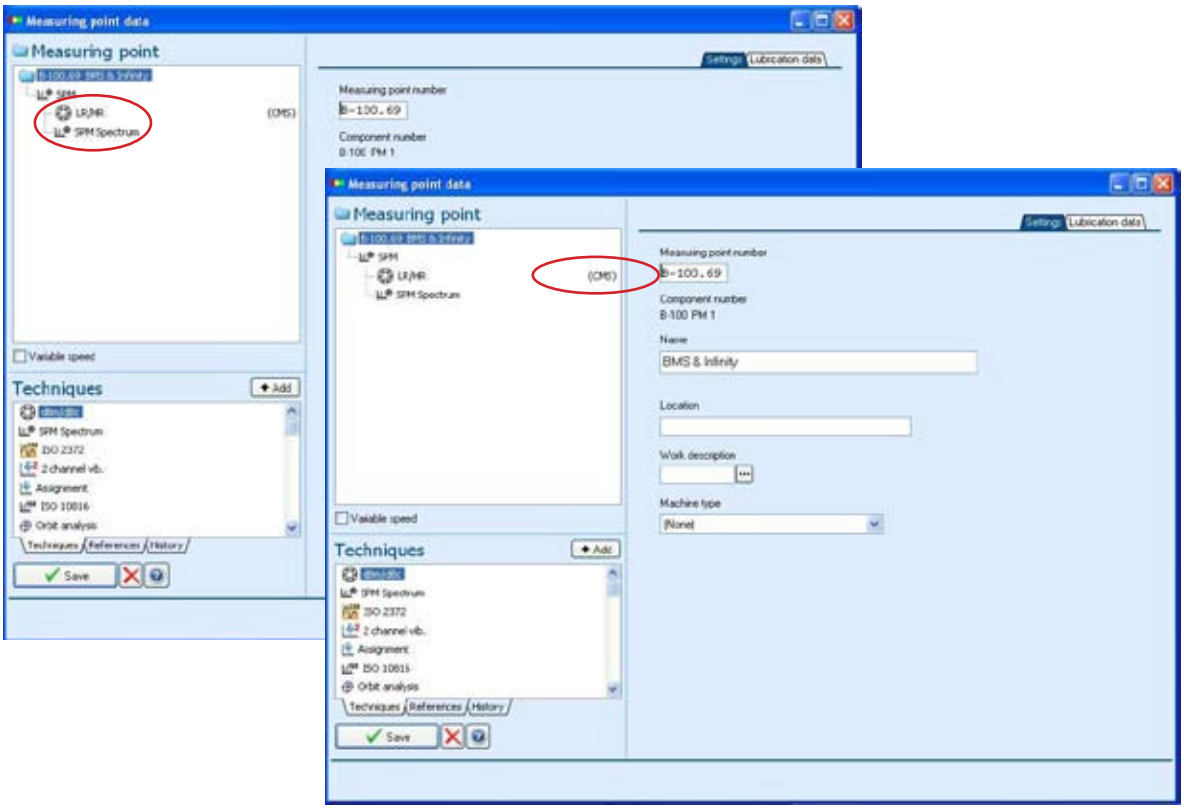

Dual shock pulse measurement techniques

Shock pulse measurement with dBm/dBc and LR/HR may be combined on the same measuring point. Take advantage of this opportunity e.g. for testing which of the two techniques works best for a given application.

Multiple measuring devices on one assignment

Multiple measuring devices may be used under the same assignment (providing the devices are activated under **System** > **Measuring System**). For instance, you may already have an online system measuring LR/HR and now you wish to complement the online measurements with SPM Spectrum measurements using Machine Evaluator. Add and remove measuring devices by right clicking the assignment.

Change order of measuring assignments

Measuring assignments may be moved up and down in the list of assignments. When measuring rounds are downloaded to a portable instrument, assignments are listed in the instrument in order of their appearance in the measuring point register. If you wish to change this order, right click on an assignment and select **Move assignment upward** or **Move assignment downward**.

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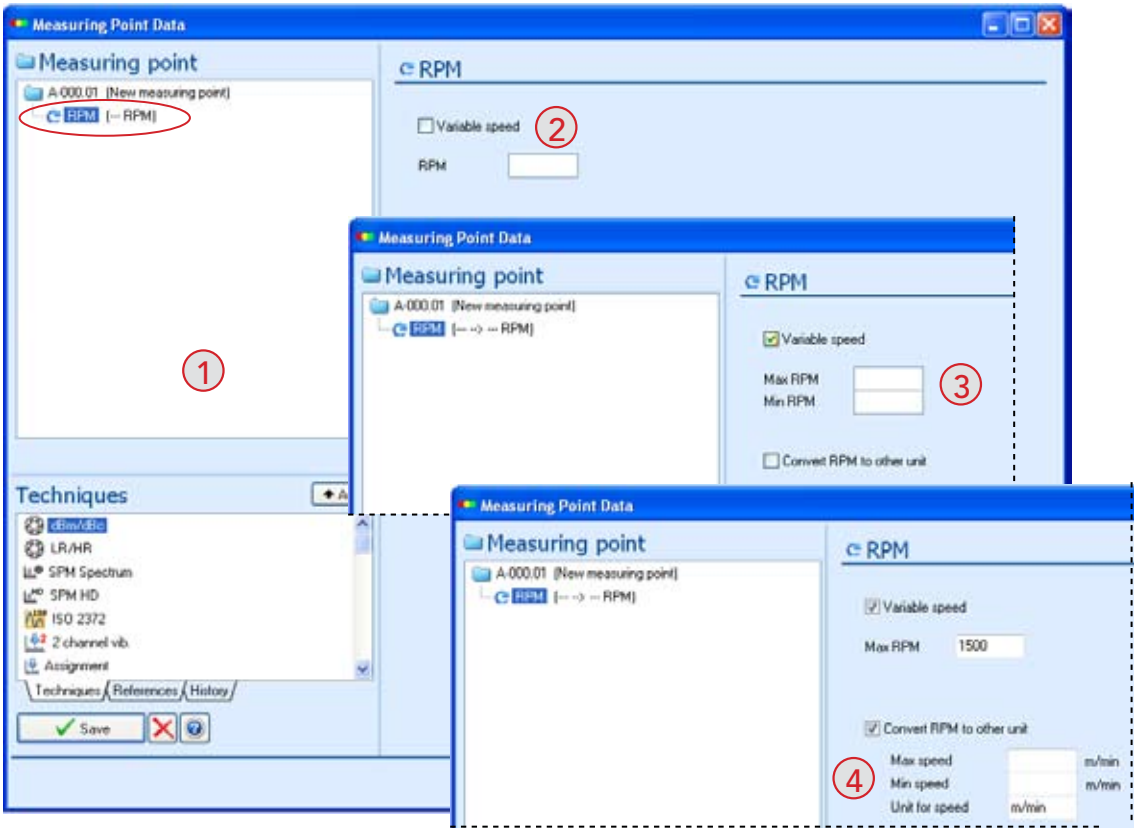

General RPM settings for the measuring point

RPM settings are usually the same for all measuring assignments on a particular measuring point. To facilitate the configuration of RPM settings, they are now set only once per measuring point, rather than on each individual assignment. Now, when a measuring point is created, RPM automatically shows up as a "measuring technique" in its own right (1):

By default, only the **Variable speed** checkbox and an **RPM** field (2) are displayed in the form. If the **Variable speed** checkbox is ticked, **Min RPM** and **Max RPM** can be input (3). Furthermore, RPM can be converted to another, user defined unit, eg. m/min, ft/min, etc., by ticking the **Convert RPM to other unit** checkbox (4).

Min. speed may be set as required, but it is recommended that it be set to 25% of the maximum rpm value. Entering data in fields (3) is mandatory, as they determine what unit of measurement is displayed in the resulting graph.

When a measuring point is set up for variable speed, the settings and measured speed will be displayed in the resulting spectrum.

When using variable speed and the SPM dBm/dBc technique, the initial value dBi is not displayed on the form.

When using variable speed and the SPM LR/HR technique, the **Norm** number is blank. The alarm limits for **Lub**, **Cond**, and **Code** are not affected, but if you should work with alarm limits on LR and/or HR, you must input one limit at max. speed and one limit at min. speed. If Norm is set to 0 (zero), the evaluations Lub, Cond and Code are disabled.

Please note: **Variable speed** should always be marked when you want to measure an SPM Spectrum. Even a small change of the rpm affects the position of the significant spectrum lines, so please measure the machine speed instead of using fixed speed data.

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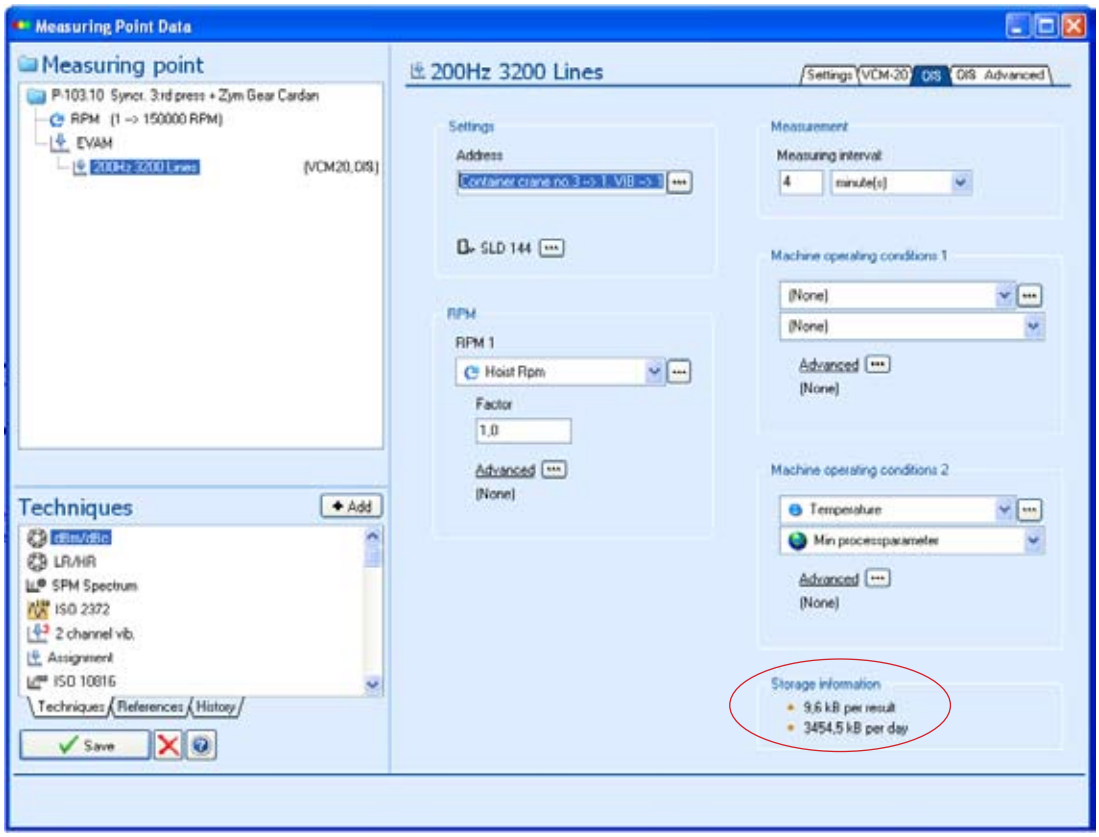

Storage information in Measuring point data

For the Machine Evaluator measuring points, the *theoretical* memory usage can be seen in the **Measuring point data** form.

The theoretical size is based on settings made on the measuring assignment. It represents the amount of space required *providing all measurements are in fact carried out according to the setup*. If for some reason they are not, it will obviously reflect on the memory usage.

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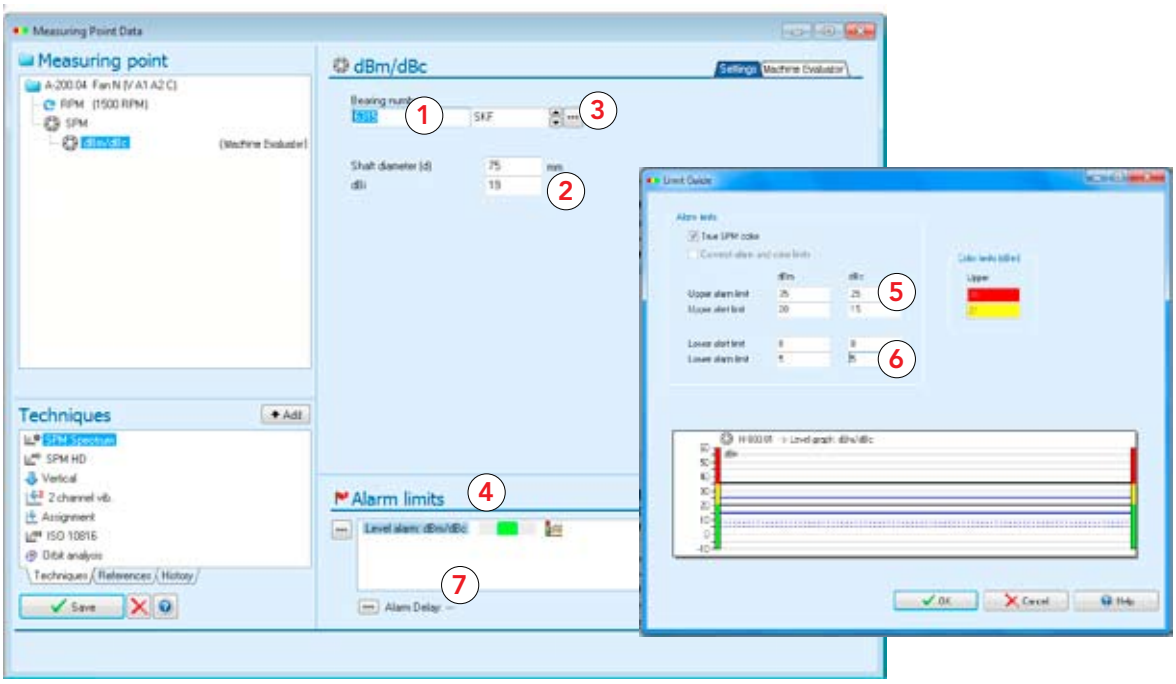

- Input ISO bearing number (1) or shaft diameter.
- Alarm limits (4) are normally set after measuring the bearing.

Input data for SPM dBm/dBc

The basic data needed for bearing monitoring using the SPM dBm/dBc technique is the ISO standard bearing number (1). The initial value dBi (2) of the bearing is automatically set after you enter these data.

As an alternative to the ISO bearing number, you can input the shaft diameter. The manufacturer name is an option. It is only needed in case you want to use SPM Spectrum or the EVAM technique for bearing monitoring. The button "..." (3) opens the bearing catalogue.

If dBi is known it can be entered directly.

SPM dBm/dBc measurements return evaluated results: values for bearing condition in dBn (dB normalized with regard to bearing size and speed). They are displayed against the green-yellow-red condition scale. The actual status of the measuring point will also be displayed as a colored dot in the Graphical Overview.

To make use of the alarm list, you must enter alarm limits (5). Once you have measuring results and know the "normal" values for a given bearing, you can edit the alarm limits, e. g. set them to 5 dB above normal.

"Upper alarm limit" (5) means that an alarm is given when the measured value is larger than the limit value. "Lower alarm limit" (6) means that you get alarm when the measured value drops below the limit.

"Alarm delay" (7) is useful to obtain stable and well justified alarms. This function delays the alarm by a user specified number of readings and determines when alarms will be raised. All readings are still saved to the Condmaster database; the "filtering" is done in the graphical display only.

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- Input ISO bearing number (1) or TYPE no. (4) and mean diameter (5).
- Input NORM (6) and ACCUM (8). COMP (7) and LR/HR alarm limits (11) are set after measuring the bearing, or not used.

Input data for SPM LR/HR

The basic data needed for bearing monitoring with the LR/HR technique is the ISO standard bearing number (1). **Type** (4) and **Mean diameter** (5) are automatically set after you enter these data. If you set **Norm** = 0 (6), you get no evaluation (unnormalized measurement: **Lub**, **Cond** and **Code** are not displayed).

As an alternative to the ISO bearing number, you can input the mean bearing diameter (5) and the **Type** no (4). For low speed bearings (below 600 rpm), set **Accumulation** (8) to 3 or higher. This returns an average of the set number of shock pulse readings.

SPM LR/HR measurements return two sets of results:

- the raw values LR (for strong pulses) and HR (for the shock carpet).
- the evaluation results LUB (lubrication number), COND (condition number), and CODE (A = good, B = poor lubrication, C = beginning damage, D = damage).

A correct evaluation often demands that you set a **Comp** no. (compensation number, 7). You cannot do this before you have measuring results which you can check with LUBMASTER. To start with, you can leave the **Comp** no. at "0" and input either "BCD" as alarm limits under **Code**, or "0" under LUB and "32" under **Cond**. Once you have measuring results, you can fine tune your alarm conditions by introducing a **Comp** no. For this, use the button (7) to go to LUBMASTER, see under that header.

To make use of the alarm list, you must enter alarm limits (9). Once you have measuring results and know the "normal" values for a given bearing, you can edit the alarm limits. As an alternative, you may disregard the evaluation code and trend the LR/HR values plus set alarm limits for those (11), also selected with the help of LUBMASTER.

"Alarm delay" (10) is useful to obtain stable and well justified alarms.

The field **TLT limit** under Machine Evaluator (12) is normally set to "15". For measuring points with remote transducer, e.g. Ex transducers, a lower value can be set to force acceptance of a lower transducer line quality number without causing a TLT warning. For regular transducers however, alarm limits below 15 is not recommended.

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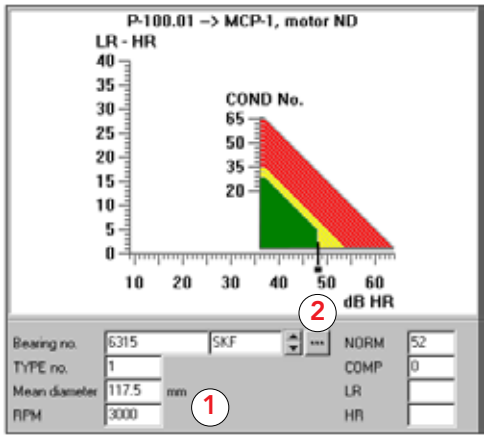

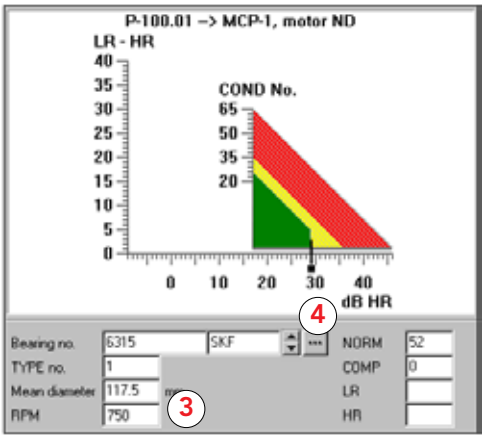

Lubmaster:

- From the measuring point data forms, click on the LUBMASTER icon.
- Input the max. (1) and min. (3) rpm to see the corresponding HR scales (2, 3).

	Min	Max
LR Upper	34	52
LR Lower		
HR Upper	29	47
HR Lower		

SPM LR/HR, connection to Lubmaster

When **Variable speed** is marked, Condmaster needs two alarm limits on LR/HR. Please note that alarm limits on LR and/or HR are an option. You do not have to use them, but if you do, you need two. LUBMASTER helps you find them.

Given the ISO bearing number and the rpm, LUBMASTER will show the evaluation frame for the bearing. The LR/HR values should be within the green zone of the frame while bearing condition is good. Thus, the border between the green and the yellow zone is a suitable alarm limit.

In the first frame above, the minimum rpm has been input in field (1). The corresponding HR alarm limit is 29 (2). Changing the input to the maximum speed (3) pushes the HR limit to 47 (4). In both cases, set the LR value to HR+5.

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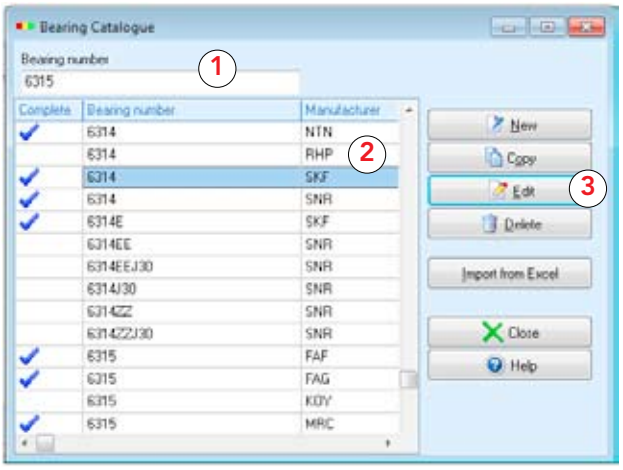

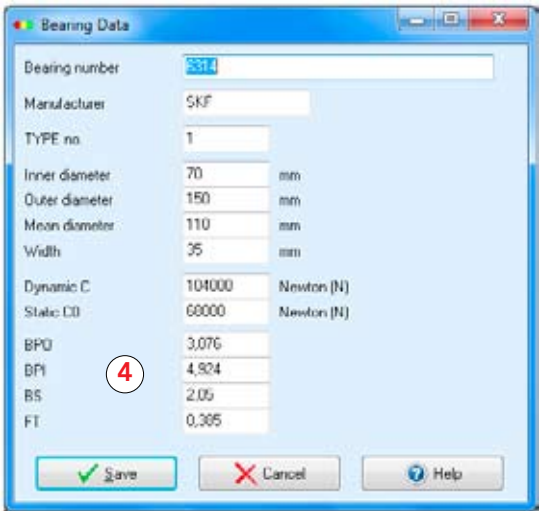

Bearing catalogue:

- From the measuring point data forms, click "**...**" to search for the bearing.
- From the bearing catalogue under **Registers** in the menu bar, click **EDIT** to see the data.

Using the bearing catalogue

The ISO bearing number is very useful, and you should work with it whenever possible. It links your measuring point data to the Condmaster Nova bearing catalogue which contains all data needed for shock pulse evaluation, LUBMASTER, EVAM, SPM HD and SPM Spectrum analysis of most bearings.

To find a bearing, enter the number in field (1), then select bearing and manufacturer (2).

Click **EDIT** (3) to see the data. The four entries at the bottom of the list (4) are the factors used by Condmaster to configure the symptoms for bearing pattern recognition (SPM HD, SPM Spectrum, EVAM enveloping spectrum).

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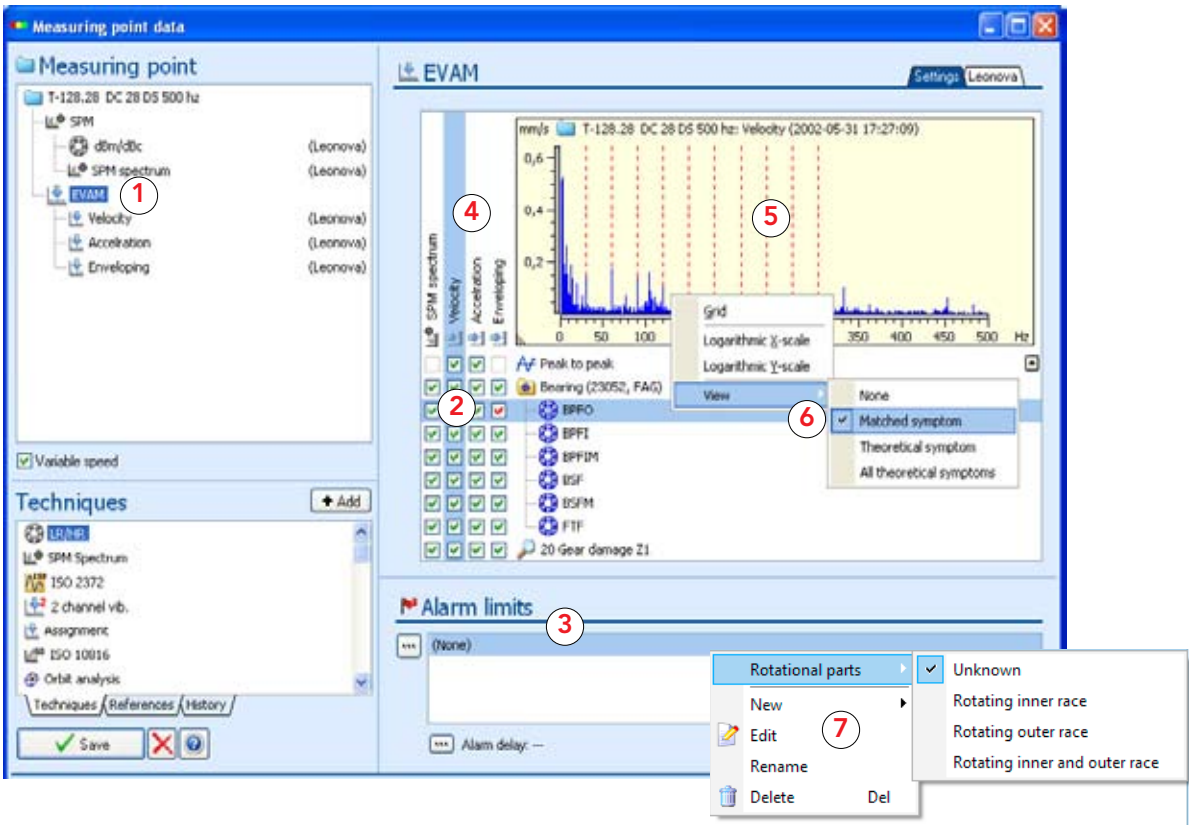

Overview of assignments

Mark the measuring point in the tree structure, right click with the mouse and select Edit to open the **Measuring Point Data** form. When SPM HD, SPM Spectrum or EVAM measuring technique is marked in the Measuring Point Data form, an overview of all symptoms and condition parameters for this technique is displayed in the **technique window** in right part of the form.

Click on one of the parameters/symptoms in the list to display the corresponding graph in the technique window. Use the UP and DOWN arrow buttons on your keyboard to move through the list.

The symptoms are enabled to the assignments by marking them in the **Symptom list** (2). A green check mark in the box shows that the assignment is enabled and a red check mark shows that the assignment is set up with alarm limits (3). The assignments (4) are shown in the upper part of the technique window. Here you can determine what symptoms to be displayed in the graphics for each of the assignments.

After you have measured, the spectrum window (5) will show the latest measuring result when you open this form. Right click in the graph for further display options (6). You can select logarithmic scales and view matched or theoretical symptoms. Click the measurement unit on the horizontal scale to switch between rpm, Hz and orders.

Selection of rotating bearing part
For vibration, SPM HD and SPM Spectrum assignments, the rotating part of the bearing can be selected (7), thereby excluding irrelevant symptoms. For instance, in an application where the load is on the bearing inner ring, selecting **Rotating inner race** disables outer ring modulation (BPFOM).

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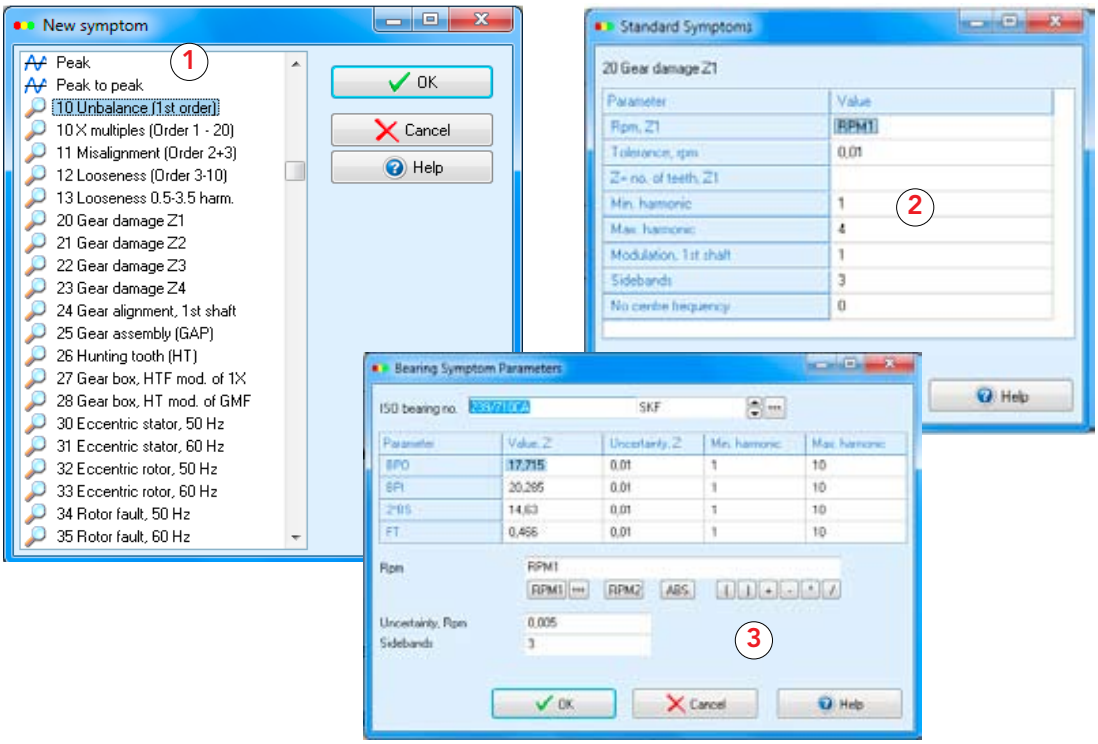

Overview, edit symptoms

You can add symptoms from the symptom register (1) to the measuring point, rename and edit the symptoms by right clicking in the symptom field in the assignment overview.

Use **NEW** and **ADD** to get the list of available choices (for details, please see under "EVAM: all condition parameters" in chapter "Measuring Techniques - EVAM"). **ADD** appends the new item to your selection. Select a symptom, name it and make the settings in the Standard Symptoms form (2).

INSERT places the new item above the marked line on the list. **EDIT** (3) opens a window where you can configure a marked symptom.

Bearing symptoms
To recognize bearing patterns in a spectrum, use the symptom group **Bearing**. Condmaster contains several bearing groups, which are identical except for the number of multiples which are highlighted.

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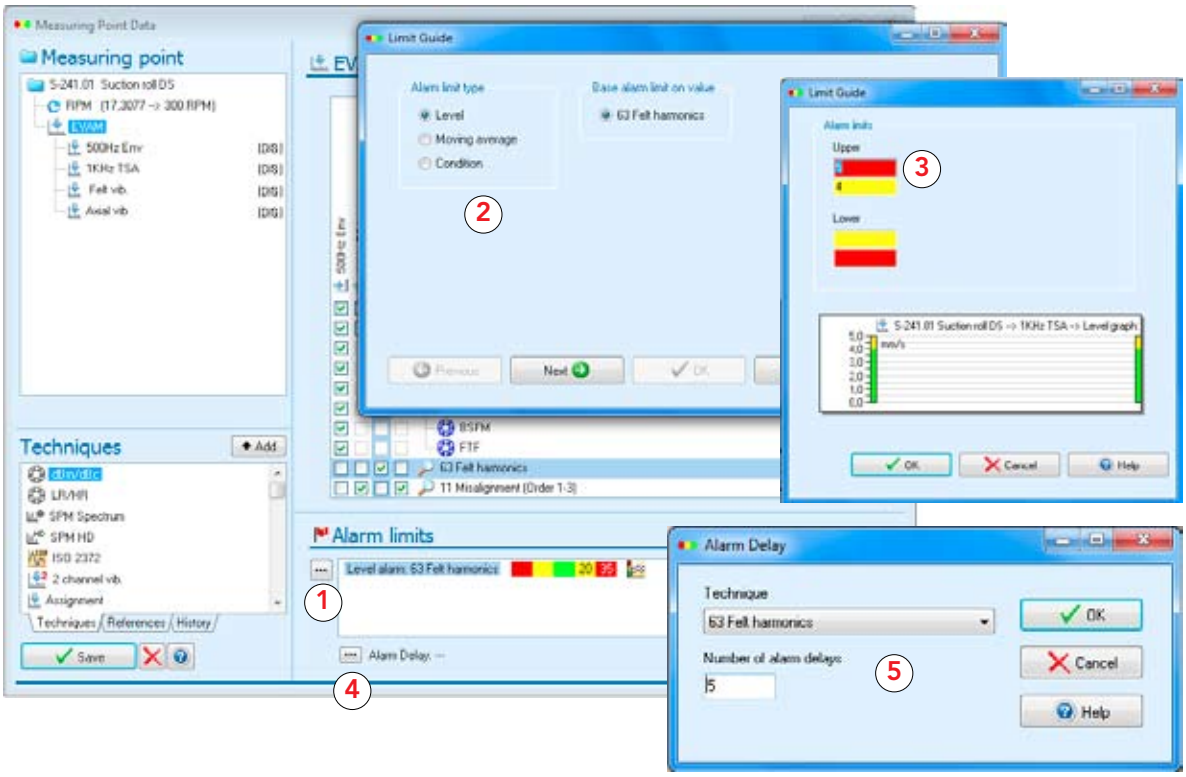

Overview, alarm limits and alarm delay

You can edit, add new and delete alarm limits for the symptoms. Mark the assignment and the symptom to be changed and press the button (1). In the **Limit guide** (2) you can set the **Alarm limit type**:

- *Level alarms*, i.e. an alert or alarm is triggered whenever a measured parameter reaches a certain, user defined threshold. This type of alarm is static and therefore works well on applications running with fixed speed and stable loads.
- *Moving average alarms*; essentially the same as above but the value triggering the alarm is a calculated average of a user defined number of measuring results rather than one individual reading. With moving average, alarms caused by sudden and random amplitude increases are avoided. The system calculates a mean value of *x* number of readings and calculates a new mean every time a new reading is registered. The higher the number of readings for mean calculation, the flatter the resulting curve will be. Moving average alarms are preferably used on applications subjected to randomly high readings from unexpected events.
- *Condition alarms;* static alarm limits that will remain the same irrespective of machine running condition. Alarm limits based on RPM or machine operating conditions will vary depending on established machine baseline settings. See also the chapter "Condition Manager" under "Evam Evaluation".

"Upper alarm limit" (3) means that an alarm is given when the measured value is larger than the limit value. "Lower alarm limit" means that you get alarm when the measured value drops below the limit.

"Alarm delay" is useful to obtain stable and well justified alarms. Press the button (4) to open the alarm delay settings where you select the technique and the number of delays. This function delays the alarm by a user specified number of readings and determines when alarms will be raised. All readings are still saved to the Condmaster database; the "filtering" is done in the graphical display only.

See also the chapter "Evaluation Functions" under "Handling of alarms and symptoms".

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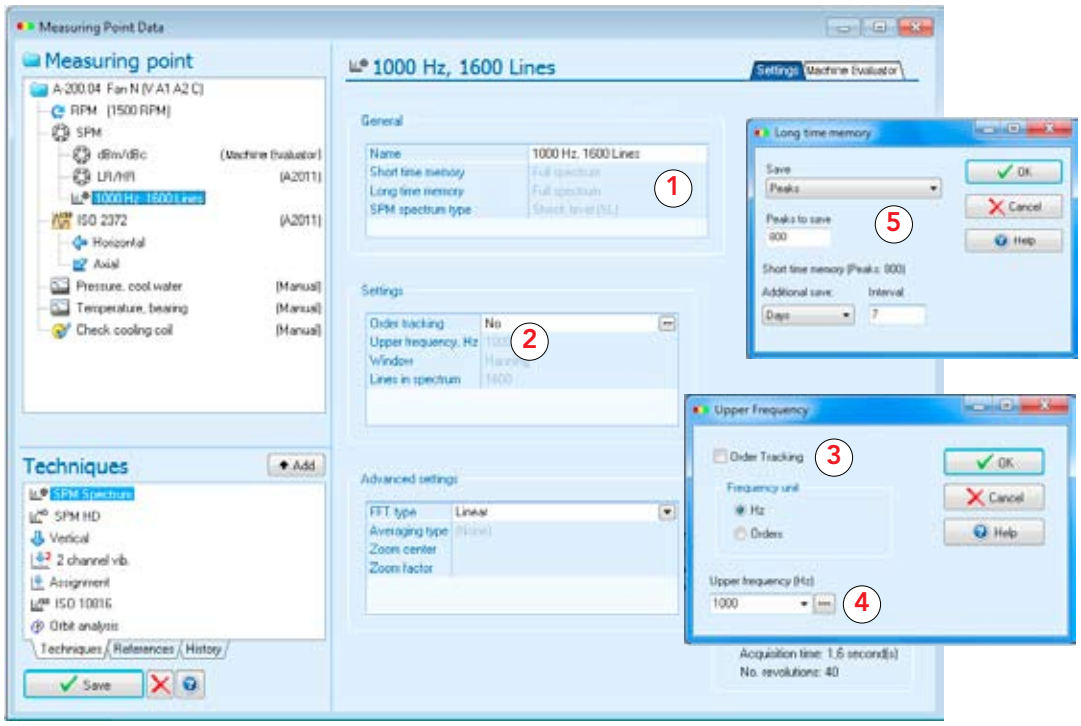

SPM Spectrum, input data

The default range for SPM Spectrum is 0 to 1000 Hz, 1600 lines, full spectrum.

This gives a good overview with room for several multiples of the bearing symptoms. In a power spectrum, line amplitudes are squared, which puts an emphasis on large amplitude lines while suppressing the smaller lines.

General

The frequency range, the number of spectrum lines, spectrum type and number of peaks to save can all be edited (1). For number of peaks to save, any figure up to half the number of lines in the spectrum can be entered. You can select full spectrum or number of peaks to save in the memory, short or long time memory. Under "Long time memory" (5) you can select measurement results from the short time memory, with time interval or after a number of measurements, to be saved in the long time memory as an addition. In the short time memory, the latest 100 readings are stored.

Settings

On the line **Upper frequency, Hz** (2), you can select a calculation function for this frequency, or orders (3) if selected, by clicking on the "**...**" button (4). First select the default symptom you want to use (selected under the flap "Machine Evaluator"), and you will get the lowest available frequency range or orders that accommodates all symptoms. Any measuring results below the lower frequency will be displayed as grey lines in the resulting spectrum. Here you also select the type of spectrum window, Rectangle, Hanning, Hamming or Flat-top, you want to use and number of lines in the spectrum.

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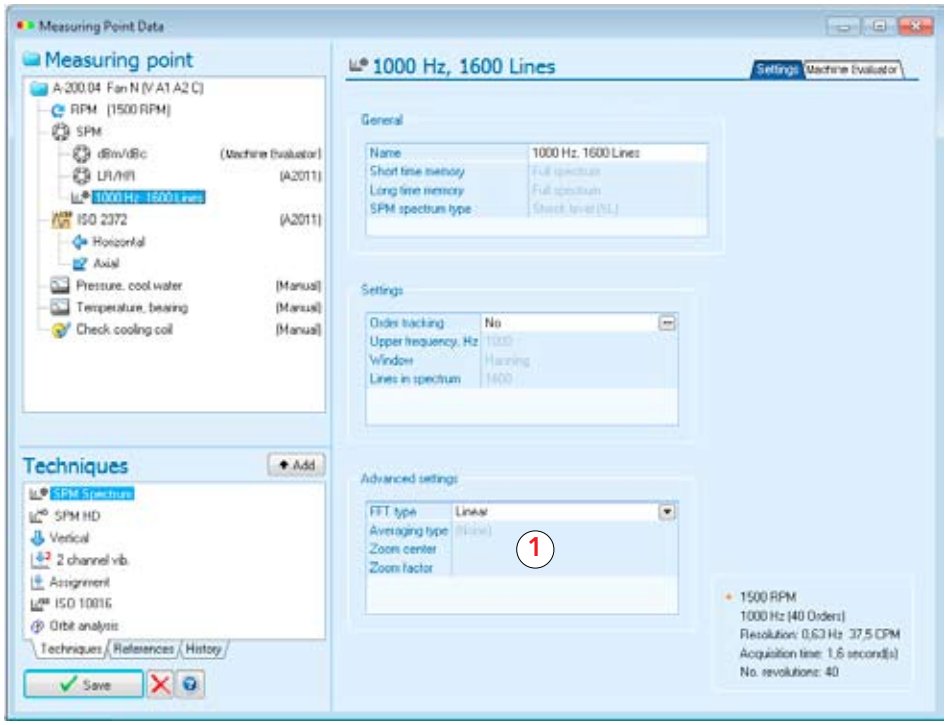

SPM Spectrum, advanced settings

Marking the check box **Advanced settings** in the lower part displays more options for setting SPM Spectrum parameters. In case an analysis is needed to distinguish between typical bearing patters and other spectrum lines, a linear spectrum with high resolution, e. g. 3200 lines over 500 Hz, should be used.

When **Always measure** is marked, the Machine Evaluator will automatically produce a spectrum with every Timken measurement, else you can choose the spectrum function at will before starting the Timken measurement with a Machine Evaluator instrument.

As FFT window, **Hanning** is the default setting. **True zoom** is normally not used in connection with the SPM Spectrum.

In Condmaster, spectrum data are saved first in a short time memory, then transferred to a long time memory, with a reduced amount of data if you so choose. This saves memory space. There is no point in saving full spectrum data indefinitely – when you get high or suspicious measuring results, the spectrum should be analyzed immediately. The size of the short time memory depends on the settings made under **Measuring system** in the menu bar, see under the heading "Measuring system, selection".

For the Machine Evaluator, the **SPM Spectrum type** can be set to **Pattern recognition (SD)**, where each spectrum is scaled so that the total RMS value of all spectrum lines = 100 S_D = the RMS value of the time record. The alternative is **Symptom value (SL)**, the RMS value of the frequency component in decibel. Alarm levels are manually set for each symptom to show evaluated results in green - yellow - red.

For information about zooming, please see section "EVAM: True zoom settings" in this chapter. "Spectrum, highlighted symptoms").

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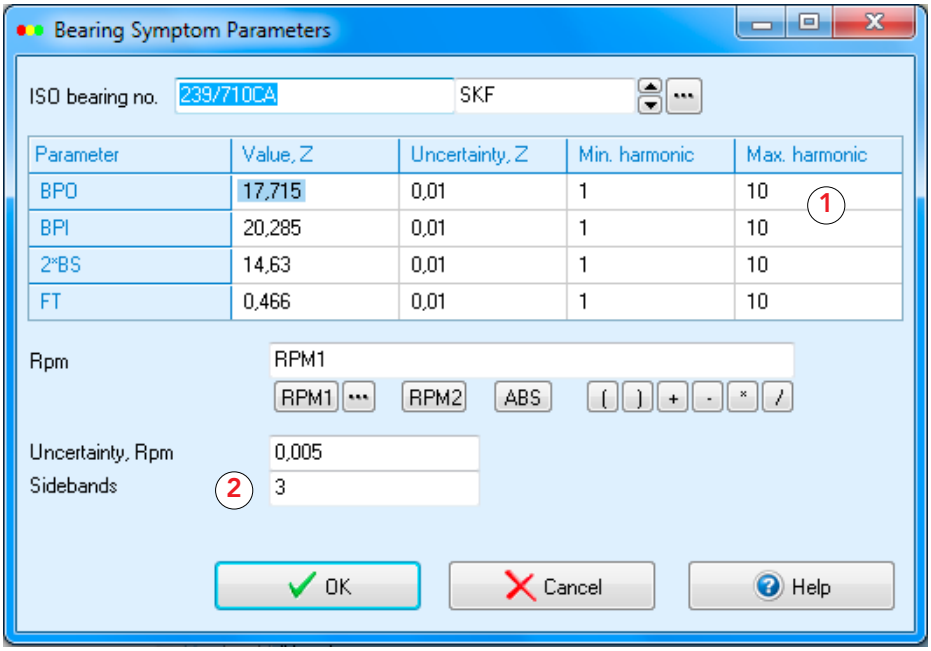

Configure bearing symptoms:

- The number of harmonics (1) and sidebands (2) can be edited

Bearing symptom parameters

For bearing symptoms, the main parameter (Z) is imported from the bearing catalogue. It should never be changed on this form. In case the catalogue data are incomplete or wrong, please edit the catalogue.

Max. harmonics (1) determines how many repetitions of the pattern are highlighted. The settings shown above (max. harmonics = 4) will highlight each pattern four times.

The symptoms BPFI (ball pass frequency, inner race) and BPFO (ball pass frequency, outer race) can be rpm modulated and have sidebands, often 3 or more. These sidebands tend to overlap when several harmonics are present, so only the 2 sidebands closest to the centre line are highlighted (2).

Please note that any changes made on this form, e. g. the entry under **Max. harmonics** or the rpm tolerance, are valid for all bearing symptoms in the group.

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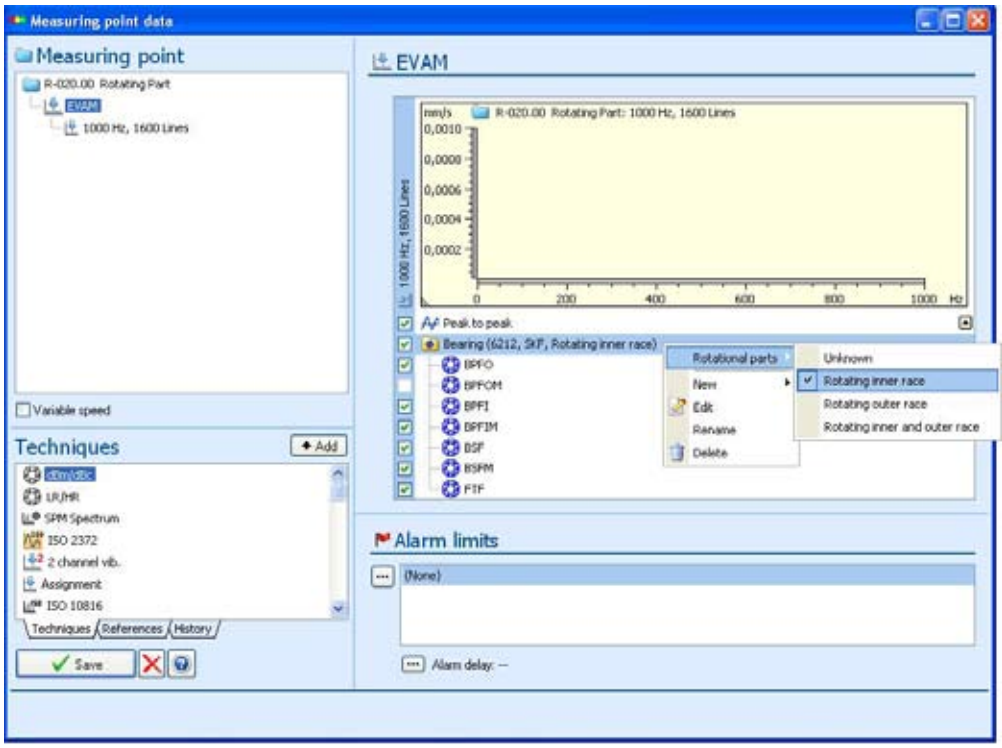

Selection of rotating bearing part

For spectrum assignments, the rotating part of the bearing can be selected, thereby excluding irrelevant symptoms. For instance, in an application where the load is on the bearing inner ring, selecting **Rotating inner race** disables outer ring modulation (BPFOM).

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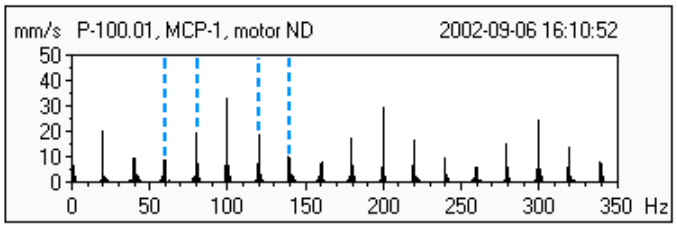
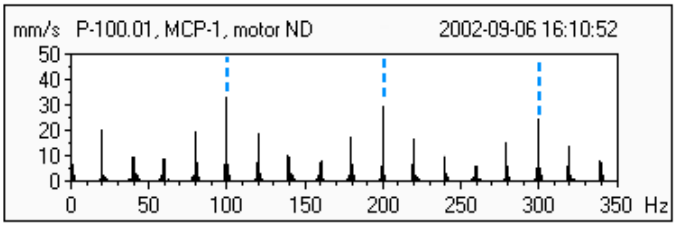
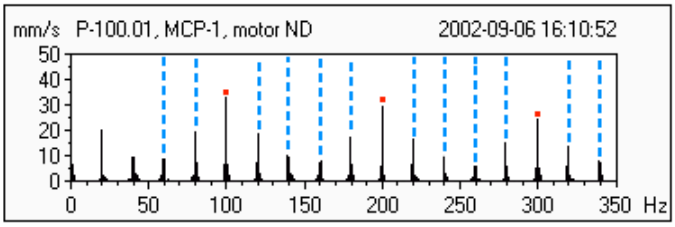


BPFIM:
Max. harmonics = 1
Sidebands = 2



BPFI:
Max. harmonics = 3
Sidebands = 2



BPFIM:
Max. harmonics = 3
Sidebands = 2
Centre frequency marked by clicking on it

SPM Spectrum, highlighted symptoms

Example 1 shows how the symptom BPFIM (ball pass frequency modulation, inner race) is highlighted by yellow lines. The setting is **Max. harmonics** = 1 and **Sidebands** = 2. Note that this symptom will only highlight the sidebands and not the centre frequency BPFI.

Example (2) shows the symptom BPFI (ball pass frequency, inner race). The setting is **Max. harmonics** = 3, so the first, second and third order are highlighted.

Example (3) shows again the symptom BPFI, but now with harmonics. By clicking on a line in the spectrum you mark it with a red square. See more under heading "Spectrum functions".

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The SPM HD measuring technique

SPM HD is a further development of the original shock pulse method, True SPM . SPM HD is available for measurement with the Machine Evaluator system only. SPM HD can be used on any application, but is particularly well suited for bearing monitoring on low speed machinery.

Users accustomed to dBm/dBc measurement will find that SPM HD is as easy to use and does not require much input data. An SPM HD measurement yields the following results:

- *HDm*, a scalar value expressed in decibels, representing the highest value measured during the measuring cycle. HDm is the primary value to use to determine the severity of a bearing damage.
- *HDc*, a scalar value expressed in decibels and a measure of lubrication condition.
- Time signal, measured simultaneously with HDm and HDc.
- Spectrum

HDm and HDc are both suitable as the basis for alarm limit definition, regardless of machine type.

When measuring with SPM HD, the measuring cycle is based on number of revolutions rather than time. This maximizes the chances of capturing relevant signals in the course of one measuring cycle. By adjusting the sampling frequency to rpm, spectrums are clear and concise also when measuring cycles are long.

SPM HD vs. SPM dBm/dBc terminology

Below is an account of the correlation of the basic terms used in the two shock pulse methods.

Quantity

SPM HD	SPM dBm/dBc	Comments
HDi	dBi	The purpose is normalization and elimination of RPM dependency. HDi covers from -15 to 40 on the dBsv scale, while dBi covers from -9 to 40. Measurement on machinery running at extremely high speeds will require manual RPM input.
HDc	dBc	HDc follows the same amplitude scale as dBc and corresponds to dBc at basically all speeds.
HDm	dBm	HDm follows the same amplitude scale as dBc and corresponds to dBm at speeds above 100 RPM.

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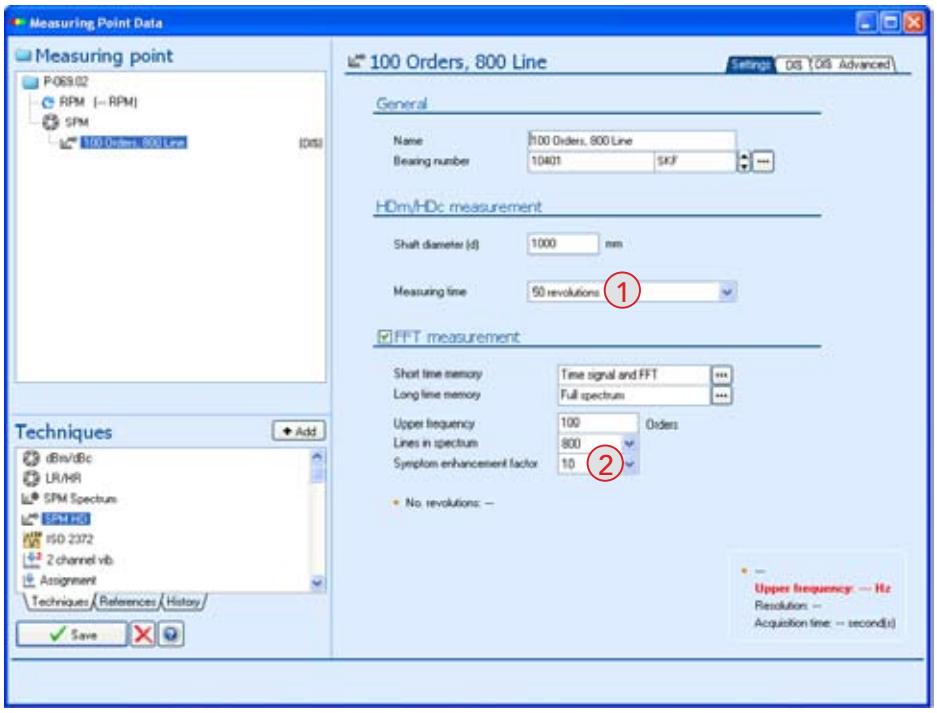

SPM HD, input data

To measure with SPM HD, the measuring technique needs to be activated for Machine Evaluator under **System** > **Measuring system**. SPM HD measuring assignments are created in the **Measuring point data** form the same way as any other assignment.

The only **Measuring point data** settings which are particular to SPM HD measurement are:

- **Measuring time**: Depending on the rpm of your application, the **Measuring time** (1) setting has a significant impact on the length of a measuring cycle. Empirical studies have shown that in order to achieve reliable measurements of bearing condition, measurement should cover *at least* 10 shaft revolutions and preferably 50 revolutions, which is the default setting. The time required to complete a measuring cycle can be calculated as 50 X (60/RPM).
- **Symptom enhancement factor**: The **Symptom enhancement factor** (2) is used to improve the signal-to-noise ratio. For applications with little electronic noise and few mechanical shock phenomena, this factor can be kept low (1 to 5). Where noise and random shocks are frequently occurring, it is recommended that the **Symptom enhancement factor** be set to at least 10. However, you should be aware that the higher this factor, the longer the measurement cycle.

  The Y axis unit in spectrum and time signal differs depending on whether or not symptom enhancement is used:

Y axis unit	*Symptom enhancement off*	*Symptom enhancement on*
In spectrum	HDsv	HDesv
In time signal	HDsv	HD^2esv

In the upper right corner of the **Measuring Point Data** form you'll find additional tabs (3) for settings of the measuring device, in this case for Machine Evaluator (see Machine Evaluator setup in the installation manual).

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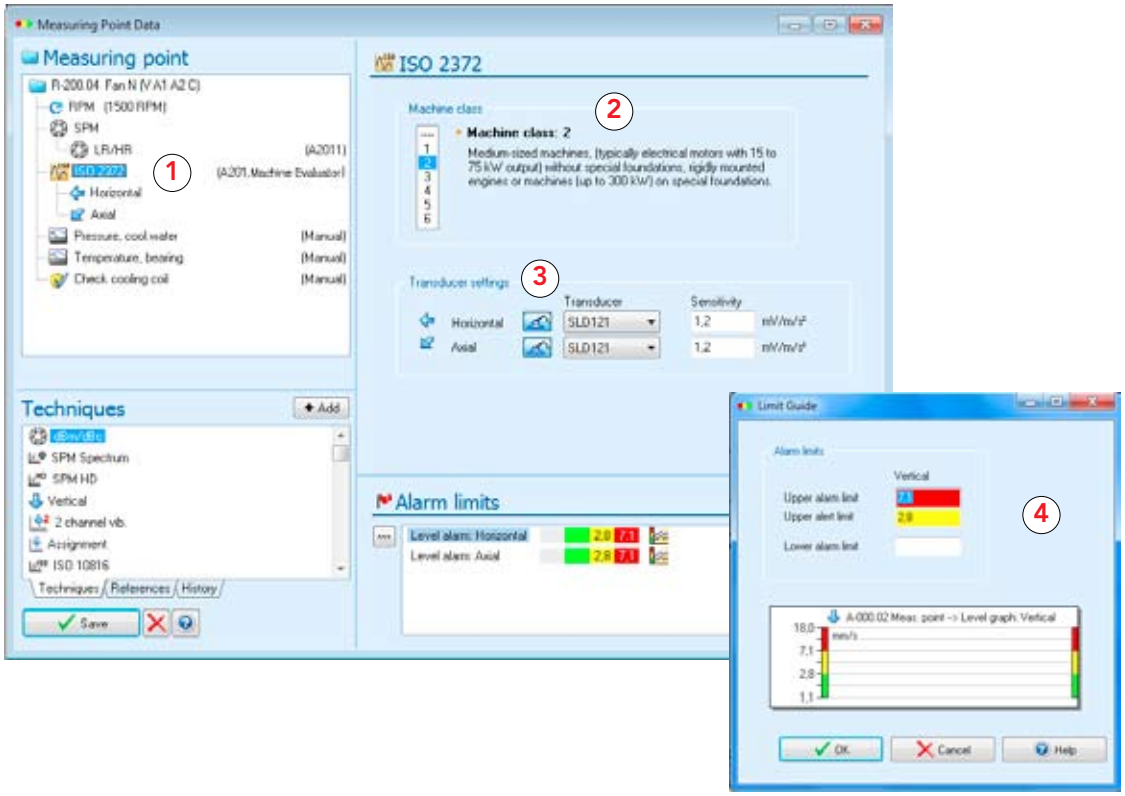

ISO 2372, input data

When the vibration assignment ISO 2372 icon (1) is marked in the Measuring Point Tree the input data form is displayed to the right. The Machine Evaluator supports all three available techniques: ISO 2372 (broadband RMS measurement, earlier called VIB in Condmaster), ISO 10816, and EVAM. ISO 10816 is a newer standard meant to replace ISO 2372. However, ISO 2372 is still widely and successfully used. In Condmaster, T/Machine Tester instruments can only be set up to use ISO 2372 for broadband measurement and EVAM.

Please note: You do not normally mix the vibration techniques but use only one of them to monitor machine condition. The EVAM method gives you the most options, whereas ISO 2372 is easiest to use.

Machine class
Selecting the ISO machine class (2) sets default values for yellow (maintain) and red alarm (stop). You can set a limit under **Lower** to get an alarm in case vibration severity drops below this value.

Transducer settings
By default, the transducer setting (3) is **Portable transducer**. When you keep this setting, the vibration transducer data will be read from the data logger that is used for measurement. As an alternative, you can select **Installed transducer** after clicking on the transducer icon. For **Installed transducer**, the compulsory input is the transducer type (pull down and select) and the transducer sensitivity. You can register your vibration transducer with its actual sensitivity, then you get this data by default.

Alarm limits
"Upper alarm limit" and "Upper alert limit" (4) means that an alarm is given when the measured value is larger than the limit value. "Lower alarm limit" means that you get alarm when the measured value drops below the limit.

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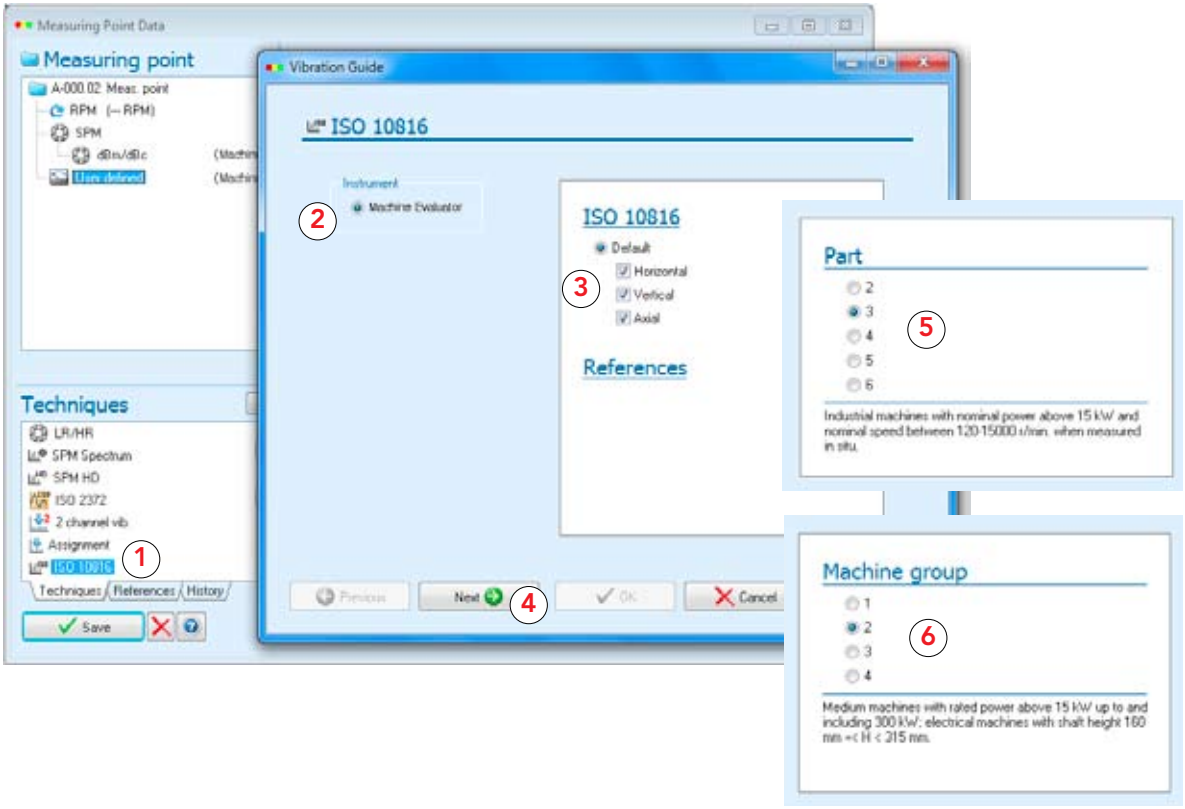

ISO 10816, input data

When the vibration technique ISO 10816 (1) is selected the **Vibration guide** will open for setup of input data. Vibration monitoring method ISO 10816 is available with the Machine Evaluator instrument and OIS only.

For ISO 10816, the vibration guide quotes the ISO definitions of the **Part** (5) (= part of the ISO standard, so far published 1 - 6) and of the **Group** (6) (group of machines treated under that part). Step through the guide with **NEXT** (4) and make you selections. The guide leads to the data input window. In Condmaster, T/Machine Tester instruments can only be set up to use ISO 2372 for broadband measurement and EVAM.

If you use ISO 10816 in your company, there should be a copy of the ISO standard available. Please go through the definitions and study the illustrations, else it is not easy to classify your machines. Most common industrial machinery, like electrical motors, pumps and fans, you will find in Part 3.

Part 6 is for reciprocating machines. There is the choice **Measure**. You are supposed to measure all three vibration parameters, velocity, acceleration and displacement. The relatively highest measuring result determines the machine's "vibration severity grade". Assuming that present machine condition is normal, the Machine Evaluator will find the lowest "Machine vibration classification number" where this result falls into the A/B range. You should then go back to the data input form and change **Measure** to the appropriate classification number, else increasing vibration values will change the classification number instead of causing an alarm.

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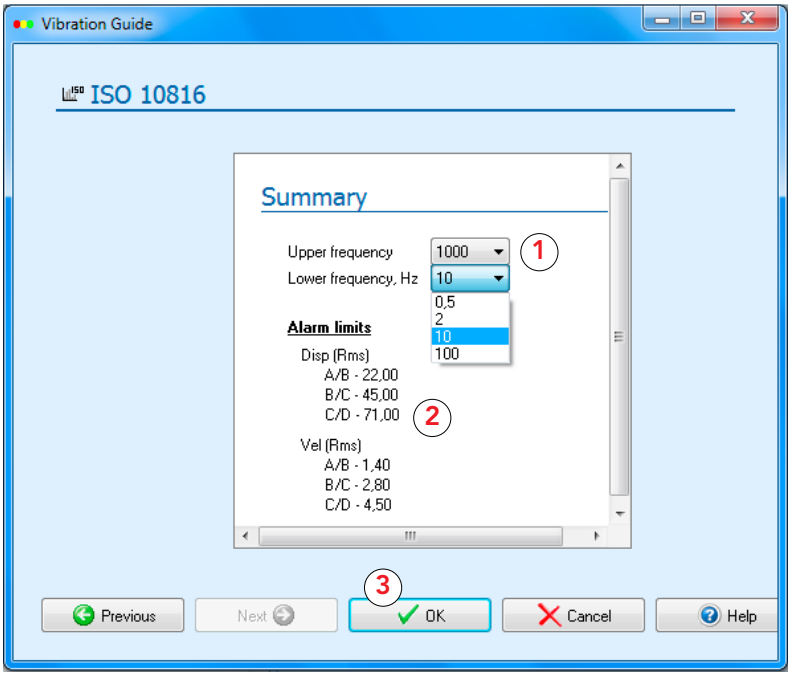

ISO 10816, input data

In the final window of the vibration guide for ISO 10816, select the measuring direction and the frequency range.

By default, the frequency is set to the ISO recommended values. Both upper and lower frequency can be edited (1). Physically, the lower frequency is limited by the transducer you are using. Most vibration transducers are not linear below 3 Hz. This affects, above all, the displacement values (DISP). For low speed applications which require true measurements of displacement you should work with a displacement transducer and not rely on the converted displacement values obtained with an accelerometer.

The vibration limit values (2) are taken from the ISO standard and can not be edited. Values below the B/C limit are in the green evaluation zone. The red evaluation zone starts with the value at C/D.

Your selection in the guide are displayed in the final window. Click **Previous** in case you want to make changes, or finish with **OK** (3).

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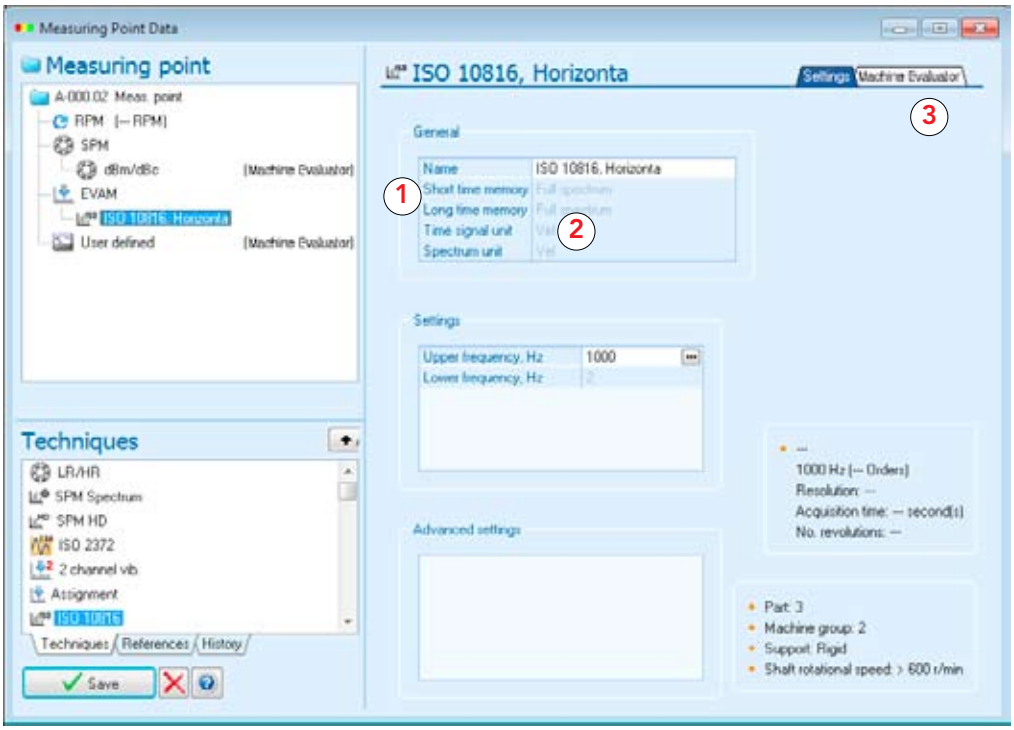

ISO 10816, input data

ISO 10816 produces a 1600 line velocity spectrum over the selected frequency range. Under **Short time memory** (1), you can decide to save the full spectrum or up to 800 peaks. In the short time memory, the latest 100 readings are stored. Under **Long time memory**, you can have a different setting. Normally, you reduce the data, like here to 50 peaks. For more information about saving data, please see section "EVAM: Saving data in short and long time memory" in this chapter.

The time signal unit (2) depends on the transducer (ACC for an accelerometer).

Speed data are not required. When the measuring point includes speed data set under other techniques, they are displayed in the data window.

Please note: Condmaster treats the ISO 10816 technique like a reduced version of the EVAM technique. In the technique window, you can right hand click on ISO 10816 and convert to EVAM.

In the upper right corner of the form you'll find tabs for Settings and for further settings that are measuring device dependent (3).

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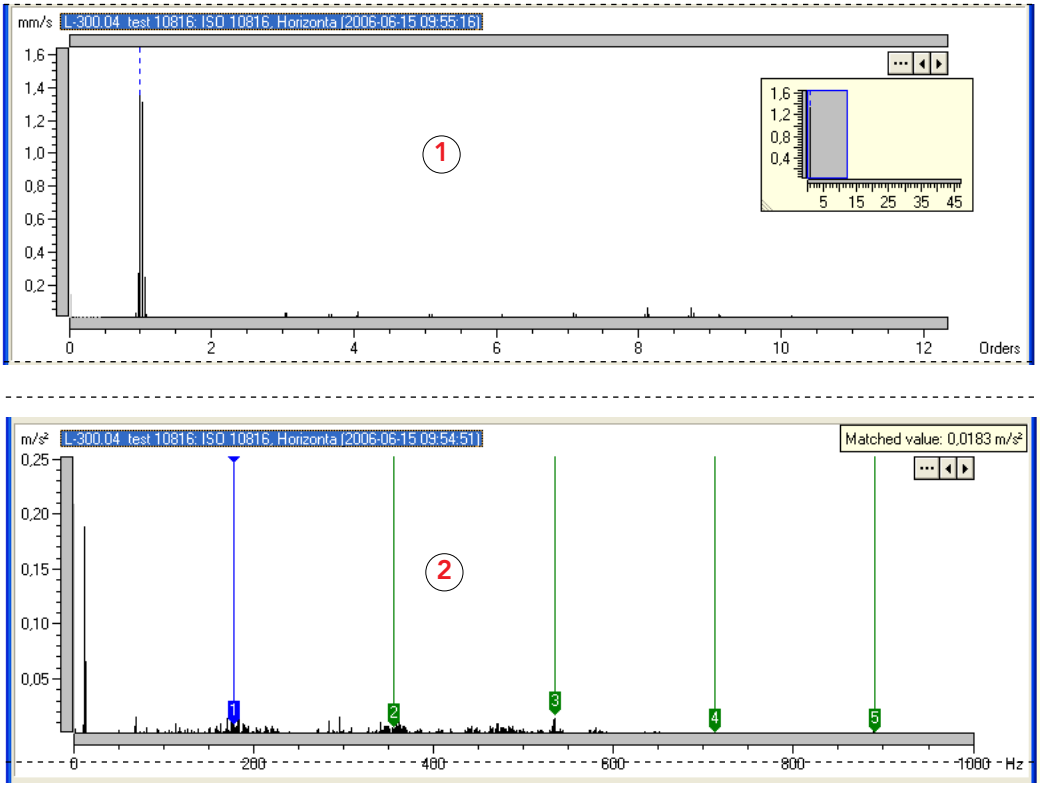

ISO 10816, spectrums

In an ISO 10816 spectrum, symptoms cannot be shown, but using a marker and the function CPM/orders, an indication of machine condition can be obtained:

- Use CPM/orders and the marker to detect imbalance at 1 x rpm (1) or alignment at 2- 3 x rpm
- Asynchronous frequencies with harmonies may indicate bearing damage (2)
- On gearboxes, sidebands at the rpm frequency with harmonies may indicate gear tooth damage

When an ISO measurement spectrum indicates problems, it is recommended that the measurement be followed up with FFT vibration analysis.

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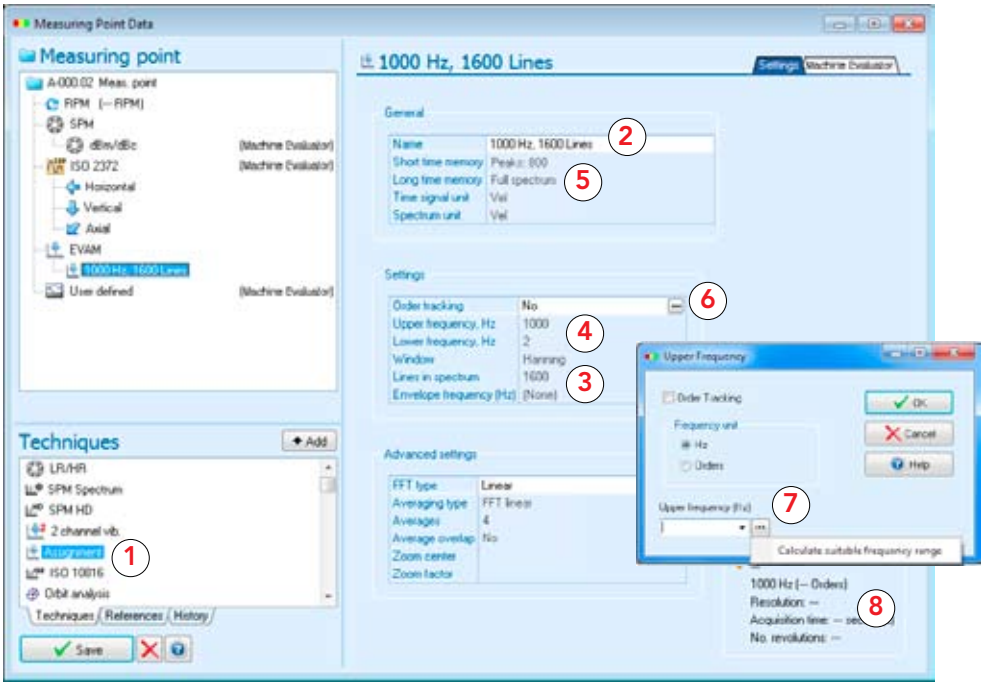

- Mark **Assignment** (1) and press Add.
- Select your instrument.
- Name the assignment (2)

EVAM assignments, input data

By default an EVAM assignment is named "Assignment" (1). Replacing this with a descriptive name (2) for the assignment is important. The assignment name turns up in the measuring technique window and on graphs and result lists. If the assignment name tells what and how you measure, you do not have to check the input data form to understand the results.

The EVAM assignment in the example above returns twelve condition parameters and a linear (3) spectrum of 1600 lines (3) over the range 2 - 1000 Hz (4), of which 800 peaks (5) are saved in the short time memory and full spectrum in the long time memory. All parameters can be edited. **Upper frequency** can be calculated by first selecting and activating a symptom (on the previous page) and then pressing "**...**" (6) and select "Calculate suitable frequency range" (7).

Measuring time and resolution depend on the set parameters. With the above settings, the assignment takes 1.6 seconds to measure and calculate and has a resolution of 0.625 Hz (8).

There is no general recommendation on how to configure an EVAM assignment. Everything depends on the machine faults you are trying to detect. You also have to distinguish between "monitoring" and "analysing" condition. Known machine faults can be easily detected by monitoring a small fraction of all the data you can collect with EVAM, so for routine measurement you would disable most of the parameters. This greatly reduces the amount of graphs and spectra which would otherwise make your database unmanageable. If an unknown vibration problem requires a detailed analysis, you can always activate more parameters and add more assignments.

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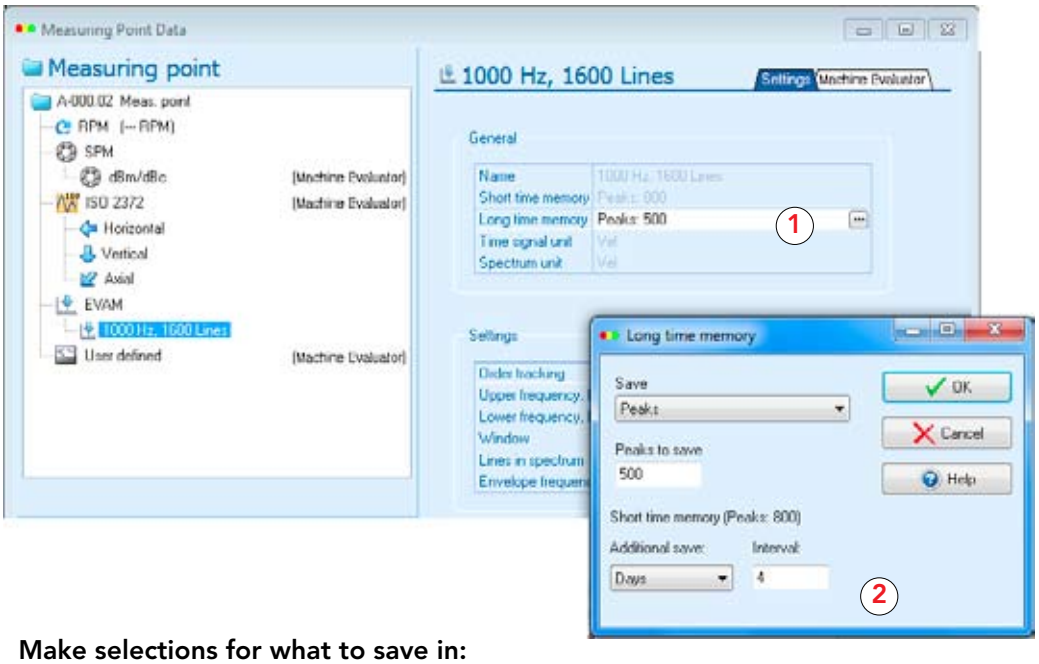

Make selections for what to save in:

- Short time memory (1): more data are usually saved here than in long term memory
- Long time memory: the amount of data saved in long time memory should be drastically reduced. Also make settings for additional save as required (2).

EVAM: Saving data in short and long time memory

The purpose of the two different memories is to save disk space. A full spectrum can take as much space as several thousand measurements without spectrum. Normally, it is desirable to reduce the amount of data transferred from short to long time memory.

In short time memory, the latest 100 EVAM results are saved. When the number of measurements exceed 100, less than the full time signal data of each measurement can be stored in order to save memory space. On a falling scale, the alternatives require memory space as follows:

- Time signal (saves the full time signal)
- Full spectrum (returns the number of lines entered under “Lines in spectrum” and contains 2,56 times less data than the time signal)
- Peaks (saves spectrum lines that have a line with a lower amplitude on either side. Thus, a maximum of half the total number of lines in a spectrum can be peaks, so you can set ”Peaks” to max. half the value entered under ”Lines in spectrum”). Machine Tester can only save peaks (up to 200).
- Condition parameters (disables the spectrum completely and returns up to twelve condition parameters. Please read ”EVAM: all condition parameters” for more information.)

Please note that you cannot store more data in long time memory than was originally saved in short time memory. If for instance only peaks are saved in short time memory, you cannot save the full time signal or full spectrum in long time memory.

Note that the condition parameters are calculated in the instruments on the basis of the measured time record. Thus, they are influenced by the frequency range but not by the spectrum type. Naturally, a lower frequency range contains less vibration energy than a larger frequency range measured under the same conditions, so RMS values measured over 10 - 500 Hz are lower than those measured over 10 - 1000 Hz.

An additional function in long term memory is the option to save regularly at an interval of your choice for hours, days or measurements (2).

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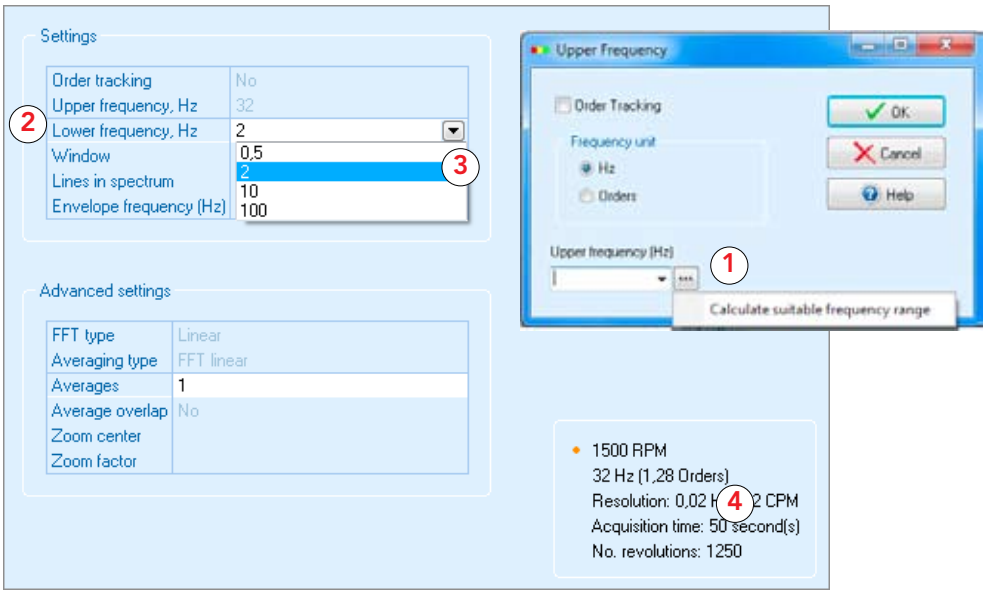

- Select upper frequency (1) and lower frequency (2) from the pulldown menus.

EVAM: Frequency range settings

The frequency range settings affect the condition parameters (slightly) and the spectrum (very much). For condition parameters, one normally uses the range 10 - 1000 Hz. This makes the condition parameter VEL comparable with the RMS value returned by ISO 2372, and the parameters VEL, ACC and DISP comparable with the values returned by ISO 10816. Machine Tester instruments are limited to 3 to 200, 500, 1000, 2000 or 5000 Hz (4).

The "**...**" button (1) selects the calculation function for **Upper frequency, Hz** (2). Select the symptoms you want to use, and get the lowest available frequency range that accommodates all symptoms.

The lower (3) frequency can be edited by selecting a value from the pulldown menu. Physically, the frequency range is limited by the transducer you are using. Accurate measurements in the high frequency range (above 1000 Hz) require a firm transducer attachment (screw mounted against a flat milled surface). Most vibration transducers are not linear below 3 Hz. This affects, above all, the displacement values (DISP). For speed applications which require true measurements of displacement you should work with a displacement transducer and not rely on the converted displacement values obtained with an accelerometer.

The frequency range for the spectrum should be large enough to contain the selected fault symptoms (see overleaf). The spectrum resolution is determined by the range divided by the number of lines in the spectrum. The selected resolution is displayed at the bottom of the screen (4).

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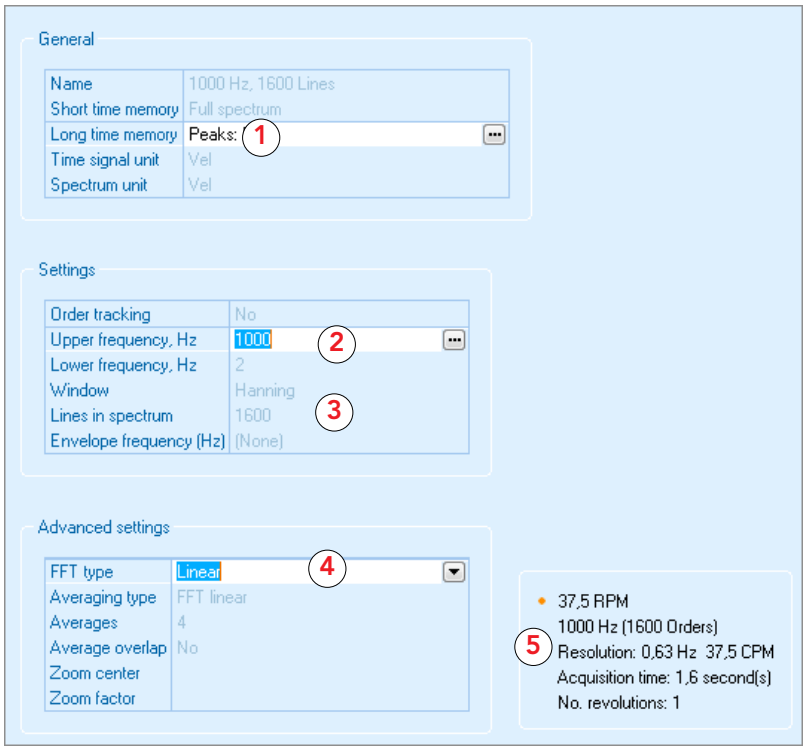
Spectrum settings:

- Select the spectrum data to save in short and long time memory (1).
- Select the frequency range (2).
- Select the number of spectrum lines (3).
- Select spectrum type (4).



EVAM: Assignment for analysis

In its platform version, the Machine Evaluator has a large measuring range (0.5 to 20 kHz) and can save up to 6400 spectrum lines. With the purchase of module MOD139 to the Machine Evaluator, the measuring range can be extended up to 40 kHz and 12800 lines. This allows you to configure spectra for all purposes. Machine Tester instruments are limited to 3 to 200, 500, 1000, 2000 or 5000 Hz, and no advanced settings are available for Machine Tester.

For information on the options for short and long time memory (1), see section "EVAM: Saving data in short and long time memory" in this chapter.

When lines from different symptoms are close together, you want a high resolution to distinguish between them. For this, you select a large number of lines over a narrow frequency range. In this example, measuring 3200 lines over 500 Hz gives a resolution of 0.156 Hz. The resolution and the acquisition time (5) are displayed after you have made your selections.

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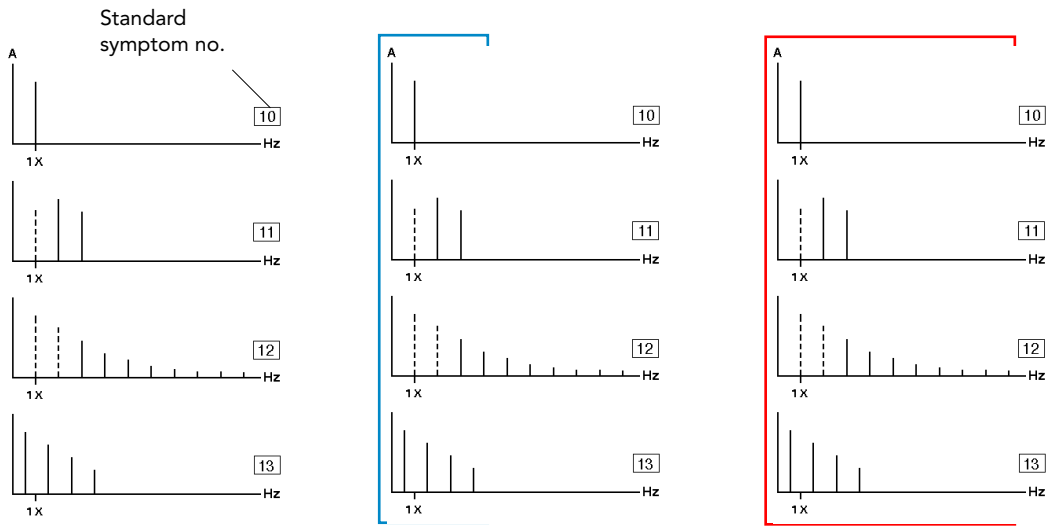

Shaft symptoms
1X = rpm/60
2968 rpm = 49.467 Hz

Shaft symptoms
1X = 49.467 Hz
Range = 200 Hz

Shaft symptoms
1X = 49.467 Hz
Range = 500 Hz

Frequency range for EVAM: Shaft symptoms

Before you create an EVAM assignment, you have to consider which frequency range to use in order to catch the fault symptoms you are interested in. The patterns you get from the symptom registers do not change, but their position in the spectrum depends on the rpm of the machine. The greater the machine speed, the larger the frequency range needed.

Above, you see the shaft symptoms, used for most types of rotating machines. The fundamental frequency is at 1X, here 2968 rpm or 49.467 Hz, i. e. very close to 50 Hz. Symptom 12, Looseness, requires the largest range, 10X or just under 500 Hz. This would suggest a measuring range of 500 Hz to accommodate the symptoms.

The resolution over 500 Hz is max. 0.0781 Hz a 6400 line spectrum. For shaft symptoms, one would normally use 800 lines (resolution 0.625 Hz) and save 400 peaks, making the min. distance between peaks 1.25 Hz. The exceptions are electric motors, which require a high resolution to distinguish between the net frequency (here 50 Hz) and 1X (here 49.467 Hz). A suitable upper frequency can easily be calculated by pressing the "..." button in the setup window.

When you work with spectra, you normally measure in one direction only, because the spectrum gives you the information on unbalance, misalignment and looseness you would try to induce from the relative differences between the RMS measurements taken in three directions. For EVAM points, choose the direction returning the highest value, or the most convenient direction if values are roughly the same.

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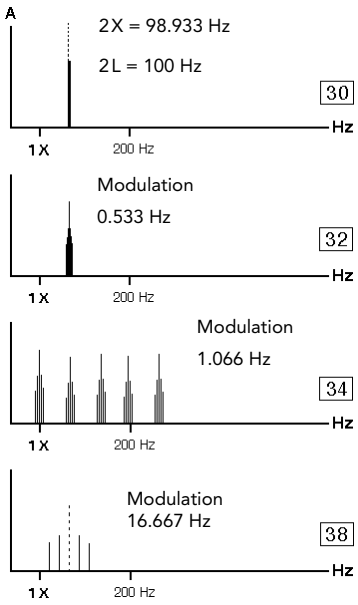
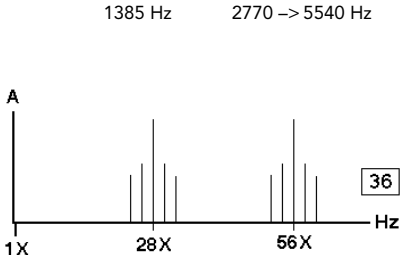
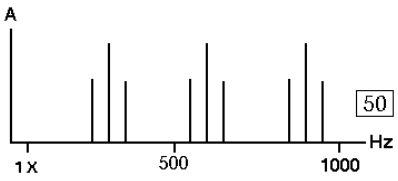


Motor symptoms, 200 Hz range
1X = 49.467 Hz



Rotor bar symptom 36, 5000 Hz
range for 1X = 49.467 Hz



Impeller symptom 50, 1000 Hz
range for 1X = 49.467 Hz

Frequency range for EVAM: motor, pump

Of the electric motor symptoms in Condmaster Nova, all but one are in the 200 Hz range for 1X ≈ 50 Hz. The rotor bar symptom 36 requires a measuring range of at least 2000 Hz.

Symptom 30 shows the effect of magnetostriction (normal in a motor and thus always present). This line at 100 Hz is here extremely close to the typical misalignment line at 2X (98.933) or the line caused by an uneven stationary air gap between rotor and stator.

Symptoms 32 and 34 require a very high resolution, because they work with the slip frequency of the motor, here only 0.533 Hz. For symptoms 30, 32 and 34 you need a zoom spectrum with the centre frequency at 100 Hz.

You also use the shaft symptoms on the motor. A simple test for electric faults in a motor can be made by turning off the power and measuring while the machine is running down. Your measuring results should drop considerably if they where affected by excessive magnetostriction or other electrical causes.

Shaft symptoms can be used as they are, but the motor symptoms 32, 34, 36 and the impeller symptom 50 must be configured.

Please note: The example above are given for a net frequency of 50 Hz. If your net frequency is 60 Hz the relationship between 1X and the motor frequencies are similar, but instead of 50 Hz and its multiples you get 60 Hz with its multiples. The motor symptoms are available for both 50 and 60 Hz net frequency.

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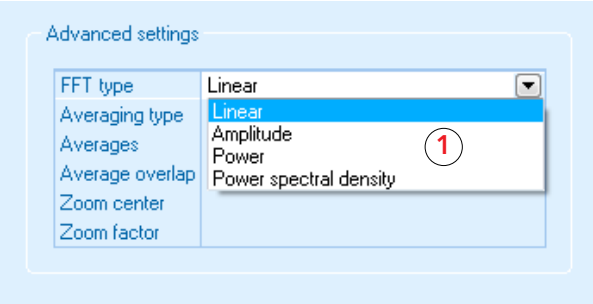
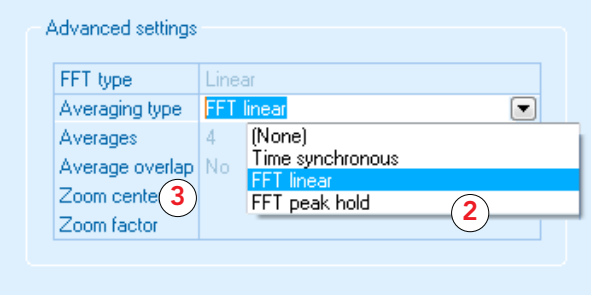
FFT type:

- Select from the menu (1). Default: Linear.



Average type:

- Select from the menu (2). Default: FFT linear, 4 readings.
- Input the number of consecutive measurements (3).



EVAM: FFT type and averaging for Machine Evaluator and OIS

The default setting for the FFT type is a linear spectrum, showing the RMS values of the spectrum line amplitudes (e. g. the RMS value of vibration velocity if velocity is the spectrum unit).

An amplitude spectrum will show peak values instead, and a power spectrum the squared RMS values. Power spectral density is the squared RMS value over a 1 Hz band.

The default setting for **Averaging type** is "FFT Linear". "FFT Peak Hold" returns the summary of the calculated spectrum, displaying all peaks occuring during measurement. Selecting "Yes" under **Averaging overlap** means that the number of measurements set under **Averages** will be overlapped in the resulting spectrum graph. Overlapping reduces data acquisition time.

Machine vibration is not a smooth, continuous signal, so each time record measured will differ somewhat from the next. To stabilize the measuring results one can use various forms of averaging. This requires more than one consecutive measurement. The number of measurements is input under **Averages** (3). Please note that the default setting (invisible unless you open **Advanced settings**) for SPM Spectrum is FFT linear averaging with four measurements.

Time synchronous averaging means that all included measurements are started with the shaft in the same position. This requires a trigger pulse from an inductive probe or the Timken tachometer probe connected to the RPM input.

"FFT linear" returns the RMS value of the spectrum lines, while "FFT peak hold" returns the highest value of each spectrum line obtained from the stated number of measurements. Thus, the combination of the FFT type "Amplitude", 4 measurements and "Peak hold" will return the maximum peak values of all spectrum lines obtained during four consecutive measurements.

For information about zooming, please see section "EVAM: True zoom settings" in this chapter.

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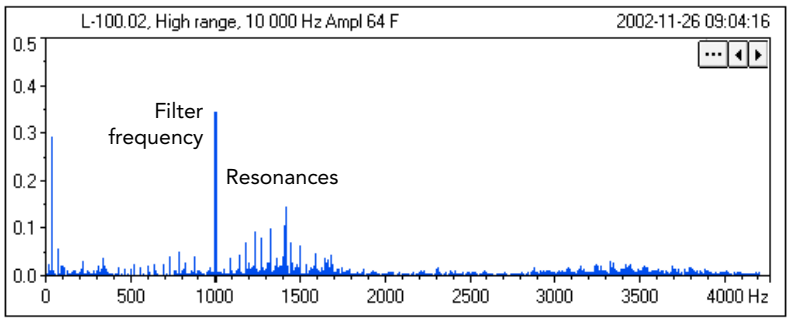
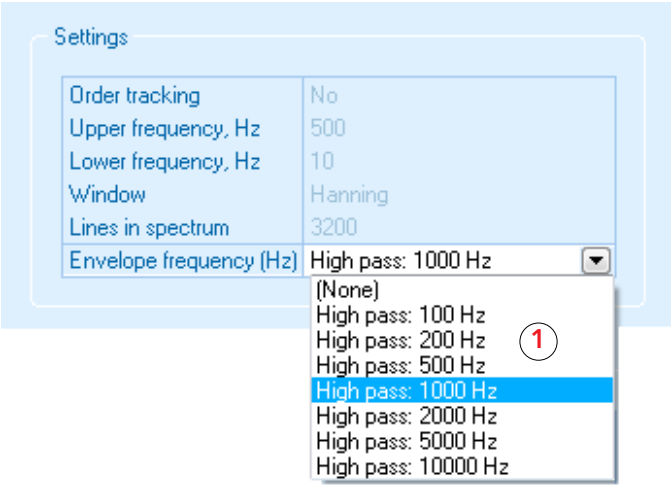


Enveloping:

- Finding machine resonances through broadband measurement

Enveloping:

- Select the high pass filter frequency from the menu (1). Default: no enveloping



EVAM: Assignment for enveloping

Enveloping is mainly used for bearing damage analysis. If you already measure bearing condition with one of the Timken techniques, you have a better option for this purpose, the SPM Spectrum, which normally gives you a much clearer signal from the bearing.

Enveloping is a technique which demodulates the amplitude of a high frequency signal and presents a spectrum of the modulating frequencies.

To find the right filter frequency (1), you should first take a broad band measurement over e. g. 5 000 Hz and look for the machine resonances. In the example above, there is a cluster of lines around 1 400 Hz and almost no signal above 2 000 Hz. The correct frequency of the high pass filter (which excludes all lower frequencies from the measurement) is here 1 000 Hz.

A rule of thumb for filter frequency selection is

- 6.25 x BPFI x RPM for machine speeds below 600 rpm
- 5.25 x BPFI x RPM (but not less than 1 000 Hz) for machine speeds 600 to 3000 rpm.

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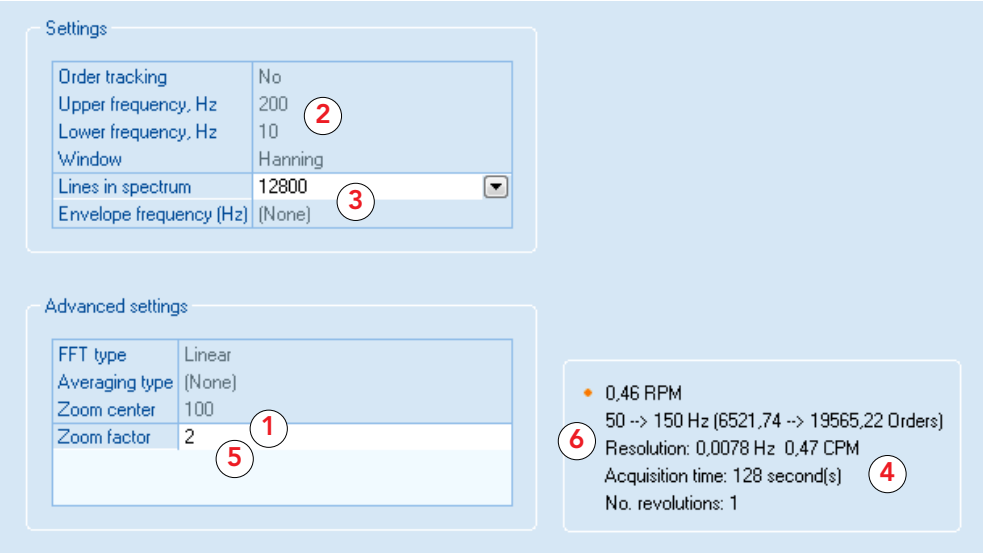

True zoom settings:

- For the type of fault you are looking for, what frequency do you wish to study in more detail? Input this frequency under **Zoom center** (1).
- What resolution is required to find the fault? Input under **Lines in spectrum** (3).
- What range above and below the zoom center is needed? Calculate as **Upper frequency**/ **Zoom factor**. N.B. **Lines in spectrum** * **Zoom factor** must not exceed 25600 (see below).

EVAM: True Zoom settings

To facilitate identification of certain symptoms, e.g. electrical faults in electrical motors, True Zoom can be used. The purpose of True Zoom is to achieve the highest possible resolution around a certain frequency. The result of a measurement with True Zoom is a spectrum which retains the number of spectrum lines but across a new and limited frequency range.

The typical frequency area to zoom is the double net frequency, 100 Hz or 120 Hz (1). A high resolution in this frequency range is necessary to distinguish between electrical and mechanical faults. Zooming in on 100 (or 120) Hz requires an upper frequency of min. 200 Hz (2).

By selecting an upper frequency twice the desired zoom frequency, an in-depth analysis can be done. In the example (above), the frequency range is set to 0-200 Hz (2). The maximum number of spectrum lines in Machine Evaluator is 12800 (3). These settings give a resolution of 0.015625 Hz (200/12800), equivalent to 0.94 rpm (4). This resolution can be doubled using True Zoom with the following settings:

- Under **Zoom center** (1), input "100" Hz (corresponds to the range to zoom)
- Under **Zoom factor** (5), input "2". The upper frequency is now divided by the zoom factor (200/2), resulting in a resolution of 0.0078 Hz (0.46 rpm).

The number of **Lines in spectrum** (3) is the deciding factor for what zoom factor can be set. If the zoom factor is too large in relation to the number of lines, the memory space allocated for measurement results will be exceeded. **Lines in spectrum** * **Zoom factor** must not exceed 25600.

The upper frequency (2) divided by the zoom factor (5) sets the size of the "zoom range" (6), which is equally distributed around the selected zoom center. Please note that the zoom range must be within the selected frequency range.

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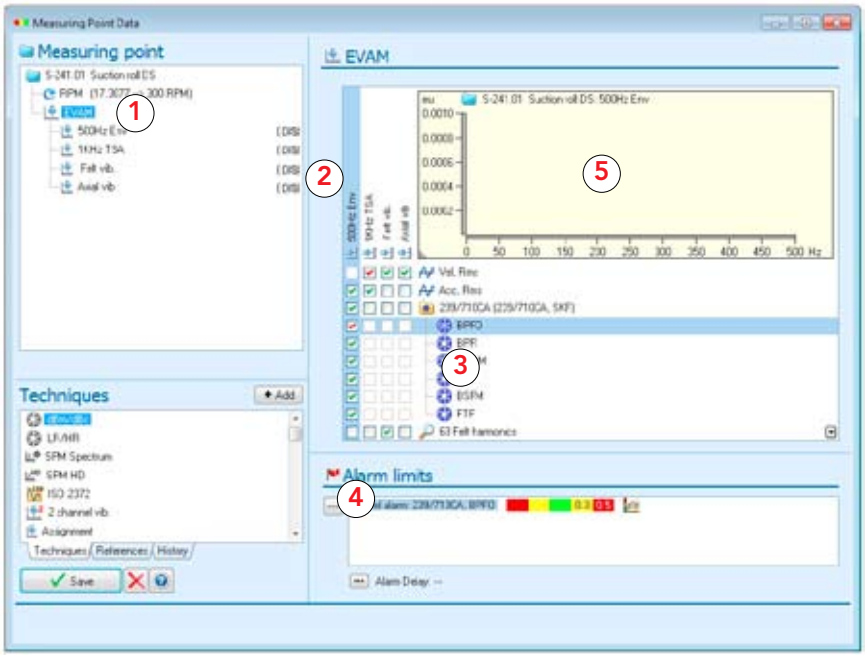

- Mark EVAM (1) to open the technique window.
- Select assignments by marking them in the check boxes (3).
- Select symptoms in the parameter/symptom list (2).

EVAM: All condition parameters

With the Machine Evaluator instruments you can measure twelve condition parameters:

- DISP = vibration displacement, RMS
- VEL = vibration velocity, RMS
- ACC = acceleration, RMS
- CREST = difference between RMS value and peak value
- KURT = kurtosis, showing the presence of transients caused by shocks
- SKEW = skewness, showing the direction of transients.
- NL1 to NL4 = noise level in the four quarters of the selected range
- the peak value of the transducer output signal
- the peak to peak value of the transducer output signal

Machine Tester instruments do not handle the noise level (NL) or peak value parameters.

All of these parameters can be useful analysing tools. For routine condition monitoring you should, however, make a selection. Vibration velocity VEL is most useful commonly measured in on industrial machines in the normal speed range. Displacement DISP is used for low speed applications (and should be measured with a true displacement transducer). Acceleration ACC is used for high speed applications.

Marking the main EVAM icon (1) will open the technique window. The assignments are shown in the upper part of the window (2). Here you can determine what symptoms to be displayed in the graphics for each of the assignments. The symptoms are enabled to the assignments by marking them in the Symptom list (3). A green check mark in the box shows that the assignment is enabled and a red check mark shows that the assignment is set up with alarm limits (4).

After you have measured, the spectrum window (5) will show the latest measuring result when you open this form.

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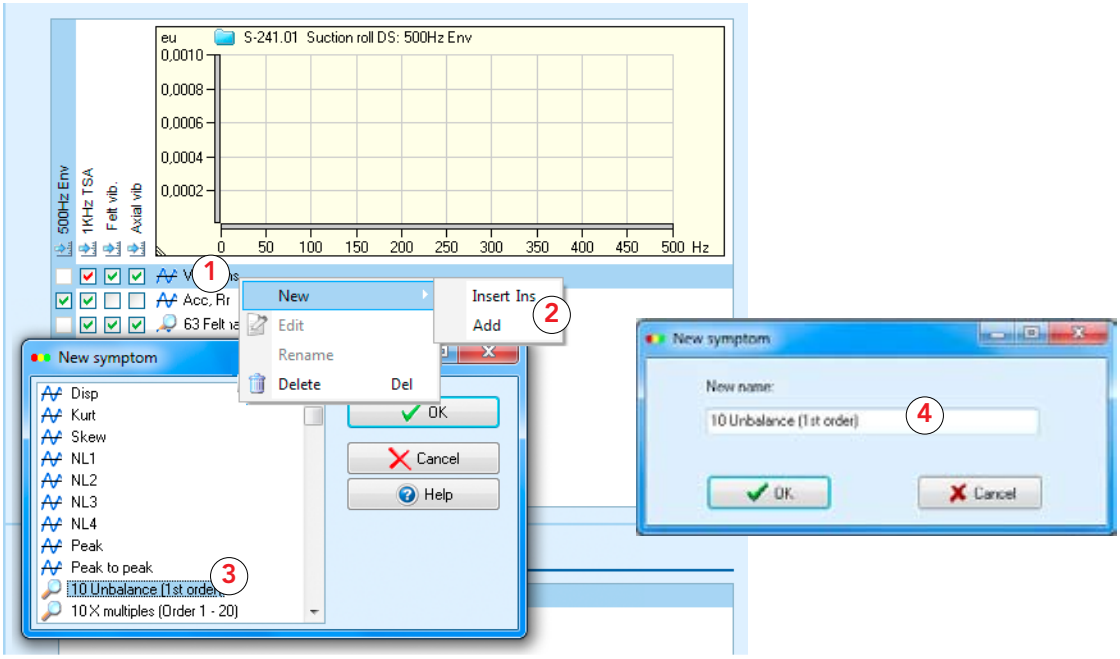

- Mark a position in the parameter window (1)
- Right click and select **New**, then **Insert** or **Add** (2)
- Select condition parameter, symptom or symptom group (3)
- You can change the symptom name (4)

EVAM: Add symptoms and symptom groups

The purpose of symptoms is to help you with pattern recognition in the spectrum. A symptom highlights the spectrum lines affected by a certain type of machine fault. In EVAM, it also adds the amplitudes of the lines involved and displays the result as the symptom value.

The simplest and most important is "10 Unbalance" which finds the line at 1X (shaft rotation in Hz). All symptoms in the group "Shaft" are combinations of 1X and its multiples (also called "orders"). The group needs no configuration because its common variable is the measured rpm of the shaft.

To add a symptom (symptom group, deleted condition parameter), position the cursor in the parameter window, then right hand click, select **New** and either **Insert** or **Add**. Select an item from the list. **Insert** inputs this item above the cursor position. **Add** places it at the bottom of the parameter window.

The list obtained with **New** (see next page) contains all available condition parameters and the contents of the symptom and symptom group registers. Select by double clicking (or mark and click **OK**). You have to repeat the sequence **New** – select – **OK** for each item you want to add to the assignment.

Menus for renaming and configuring symptoms and symptom groups are opened automatically. Renaming is an option. It is recommended that you retain the standard names (or edit the names in the registers if you prefer you own naming system), because using the same symptom under lots of different names will lead to confusion.

Most symptoms can be used without changing the configuration, some require additional data (see overleaf).

Please note: Do not clutter up your measuring points with too many symptoms. Getting the data is easy, using them takes time.

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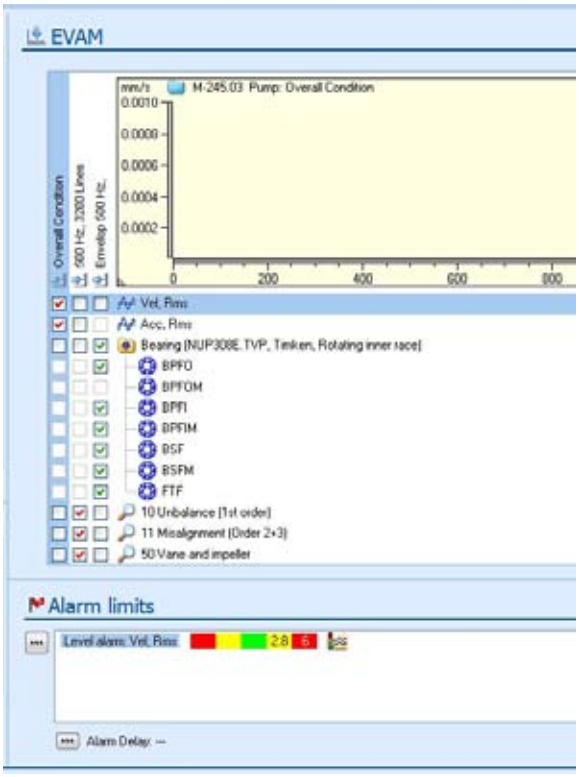

Condition:
2 condition values

500 Hz:
3 symptom values

Envelop:
6 symptom values

EVAM: Disable excessive data

The purpose of the three assignments shown above is as follows:

Overall Condition: Return the RMS value of vibration velocity (VEL) and acceleration (ACC) values, measured over the 1000 Hz range. With this value you can trend the general vibration condition of the machine and get an alarm when vibration is increasing.

Assignment **500 Hz 3200 lines**: Returns a high resolution spectrum over the range were all the interesting symptoms are located. The condition parameters are disabled, because they are covered by the Condition assignment. The symptom group Bearing is also disabled, being covered by the Envelope assignment. With this assignment, you can trend the symptom values for unbalance, misalignment, looseness and the impeller condition.

Assignment **Envelop 500 Hz**: In case you do not use SPM HD, this is your assignment for monitoring the bearing.

By systematically deleting and disabling parameters, the amount of data per measurement has been reduced, none of them doubled.

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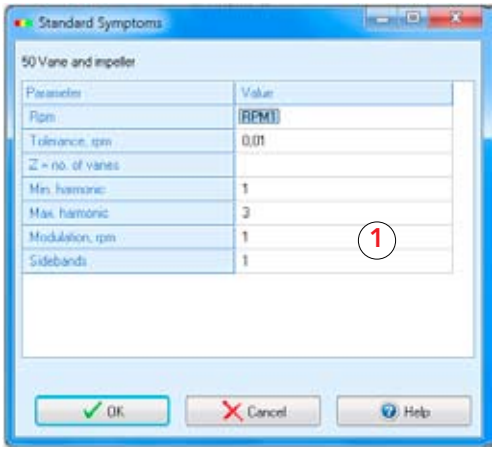
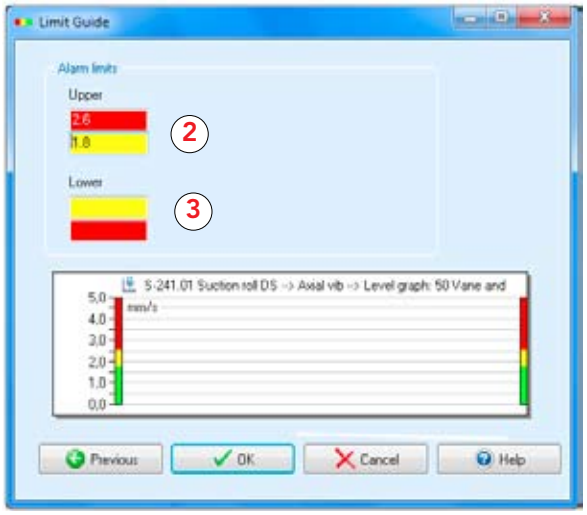


Edit symptom:

- Input/change parameter values as needed (1).
- Click **OK**



Set alarm limit

- Input upper alarm limit (2).
- When desirable, input lower alarm limit (3).
- Click **SAVE**.

EVAM: Configure symptom, set alarm limit

When you right click on a symptom on the assignment form and select **Edit**, a list of the named symptom parameters is displayed. Please make this a rule: when you add new symptoms to your Standard symptom register, name all parameters which do not have a "standard" symptom parameter value. This makes them visible on this form and saves you the trouble of going to the register to check.

The symptom **50 Vane and impeller** is one of those you must adapt to your machine. The missing parameter is **Z = number of vanes**, here the number of impeller blades in your pump. This data must be accurate, else the symptom is worthless.

Alarm limits on symptom parameter values

In case you have symptoms with stable matches and strong amplitude values, you can set both upper and lower alarm limits on these. Please check the amplitude values on scale before you decide to set alarm limits. The spectra are auto-scaled, so a long line does not, in itself, mean that it has a significant amplitude value!

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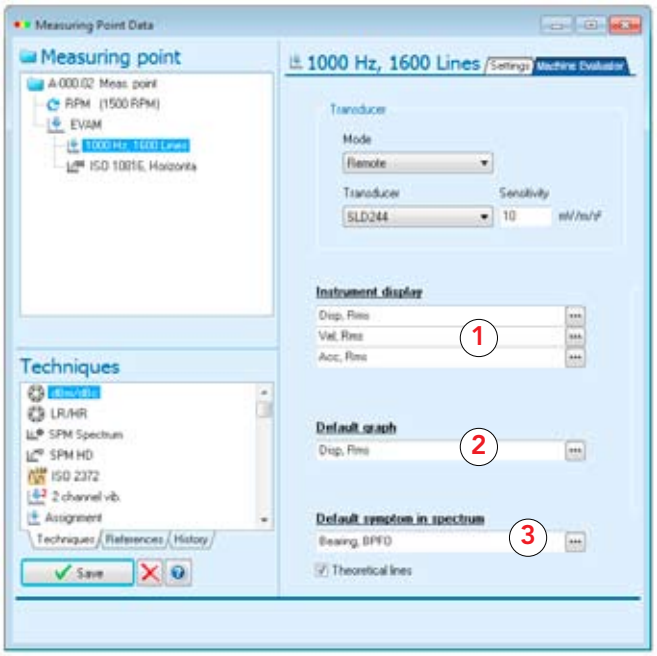

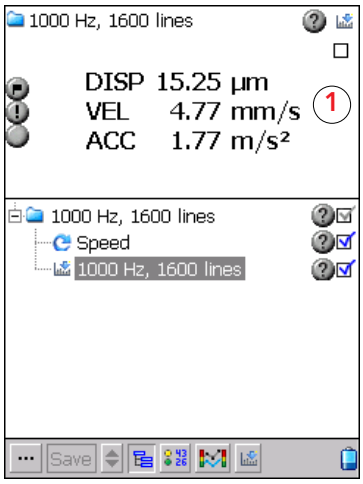

- Select 3 condition parameters for value display (1).
- Select 1 condition parameter for graphic display (2).
- Select 1 symptom for display in the spectrum (3).

EVAM: Settings for Machine Evaluator display

The Machine Evaluator can show up to three measured values on the main screen (1). Select these from the list of active condition parameters by clicking the "**...**" buttons on the **Instrument display** tab (1).

The Machine Evaluator also show a diagram of downloaded measuring results plus the newly measured result. Select a condition parameter for this display on the **Graph in instrument** tab (2).

The spectrum displayed by Machine Evaluator after a new measurement can have one symptom highlighted. Make your selection under (3) and mark **Theoretical lines**.

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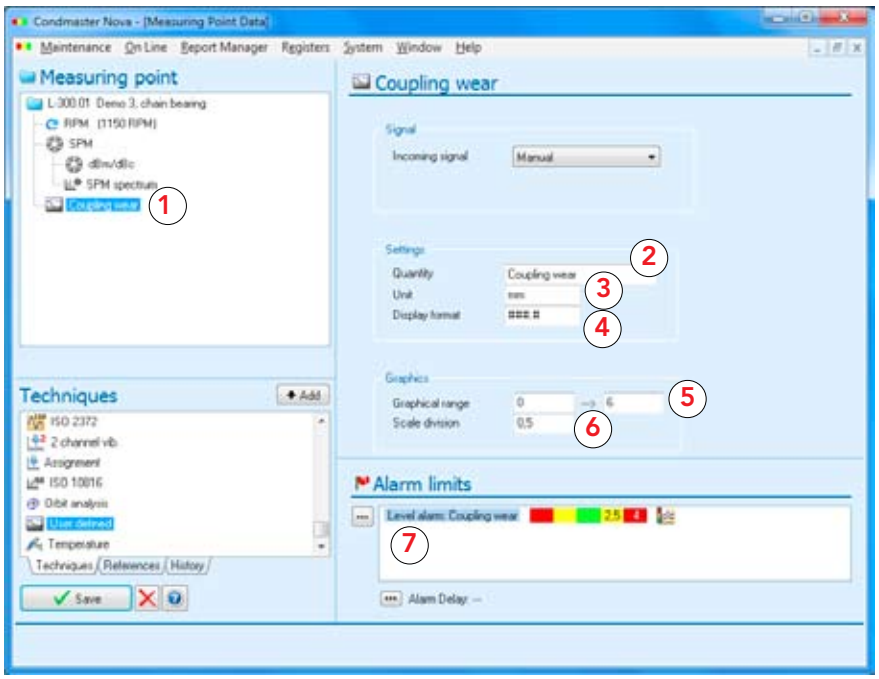

Input data for user defined measurement:

- Select **User defined**"(1). Input measured quantity (2), measuring unit (3).
- Input display format (4), display range (5), scale division (6). Set alarm limits (7).

Input data for user defined measurement

The form **User defined** has two variations. You make the selection on the technique form, either **Temperature** or **User defined** (1).

When selecting **User defined**, you get the form shown above. Select incoming signal, Manual, mA or Volt. Input the measured quantity (2, here "Coupling wear", which becomes the name of the technique, and the measuring unit (3, "mm"). You also input a display format (4) for your measuring unit, using the "#" character. "#.#" means a one digit number with one decimal.

Set the graphics range (5) to cover the min. - max. variation you want to measure. Note that readings outside of this range will be stored but require a scale adjustment under **Graphics** to become visible. Set a suitable scale division (6) for the graphics display.

You can set two lower and two upper alarm limits (7). The presence of one upper alarm limit is indicated by a red band, the presence of two upper alarm limits by a yellow and a red band above the green field. Setting lower limits produces bands below the green.

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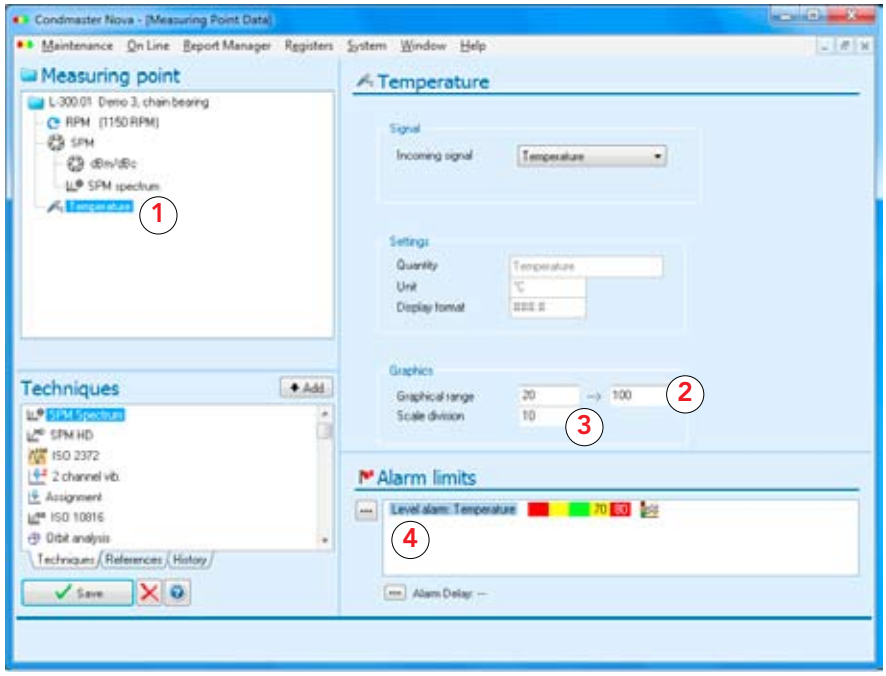

Input data for temperature measurement:

- Select "Temperature" (1).
- Input display range (2), scale division (3). Set alarm limits (4).

Input data for temperature measurement

For temperature, the measured quantity (**Temperature**) and the measuring unit (°C or °F, depending on your configuration under **System/Settings**) are preset. The display format is "###.#".

Set the graphics range to cover the min. - max. variation of the temperature you want to measure (2). Note that readings outside of this range will be stored but require a scale adjustment under **Graphics** to become visible. Sett a suitable scale division (3) for the graphics display.

You can set two lower and two upper alarm limits (4). The presence of one upper alarm limit i indicated by a red band, the presence of two upper alarm limits by a yellow and a red band above the green field. Setting lower limits produces bands below the green.

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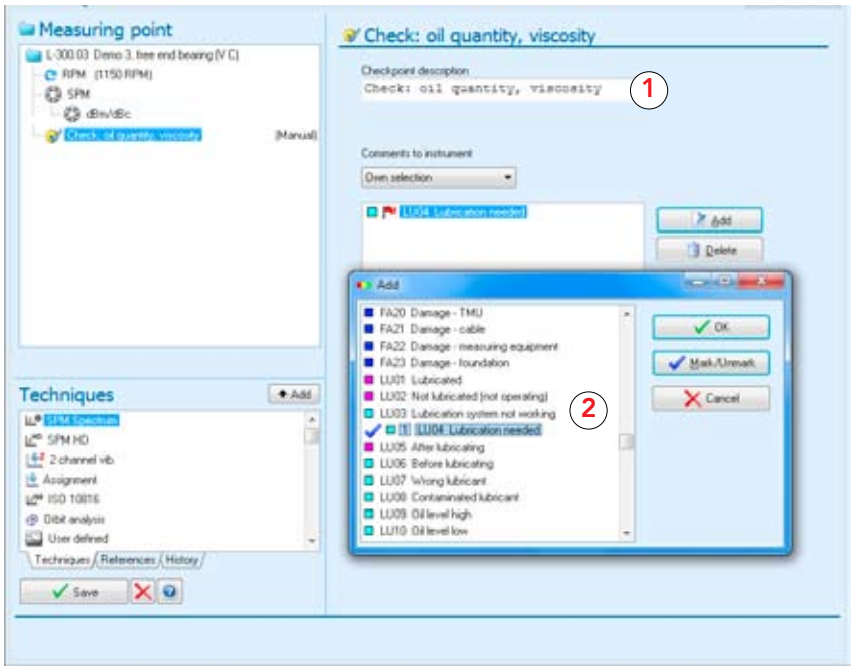

Check point:

- Input text (1). Select comments (2).

Checkpoint and comments download

The input data for checkpoints is a line of text, describing what to check. You can download checkpoints to the portable instrument and thus get a reminder to make the check. The maximum text length is 35 characters.

While you do not record any data under **Checkpoint**, you can attach a comment. This enables you to report on e. g. "General machine condition": you check for damage, leakage, cleanliness, safety hazards, etc., and can set comments like "Minor faults, fixed (no spare fuses)", or "Major damage (leaking pipe)", with an alarm attached to the latter comment.

The comments window (2) opens the list of standard comments. Machine Tester instruments take up to 16 comments. The Machine Evaluator take an unlimited number of comments, so for them you can use the alternative **All**. With **Own selection** you load only the comments you mark on the list.

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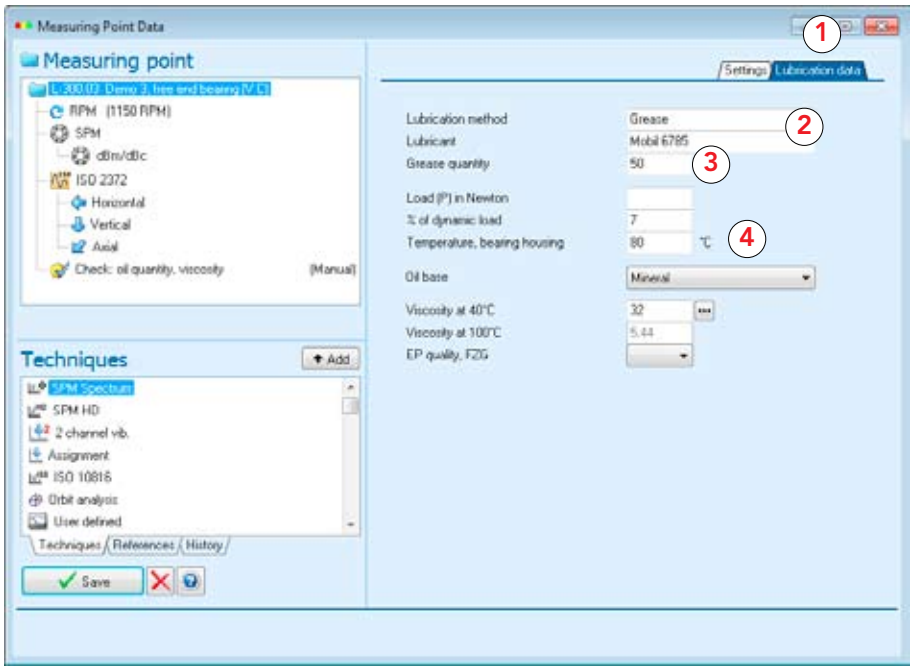

- Select Lubrication data (1)
- Input "Grease" or "Oil", brand name or type (2).
- For grease, input quantity in grams (3).
- Add data for SPM LR/HR measurements (4).

Input data for lubrication round

The input of lubrication data is an option. To verify a shock pulse reading indicating bearing damage, you should make a lubrication test, so it is useful to know what kind and how much lubricant to use.

You also have the option to make lubrication rounds (using the working mode **Planning**). With this type of round, you print a work order with all lubrication points and lubricant data.

Under **Measuring Point Data**, select **Lubrication data** (1). Input "Grease" or "Oil", brand name or type (2) and, for grease, the recommended grease quantity in grams (3).

For SPM LR/HR measuring points, you can add the lubrication data on the lower part of the form (4). This data is used by the LUBMASTER program (under **Maintenance** in the menu bar). LUBMASTER helps you to set COMP nos. as well as alarm limits for HR, LR, COND, and LUB, or you can use it to find a better lubricant for your bearing. If you enter the necessary lubrication, load and temperature data here, they will be available to LUBMASTER, else you can enter them when using that program. For details, see under the heading LUBMASTER, and also the LUBMASTER help texts, especially on load.

Load in Newton is the actual load on the bearing. As an alternative, you can input the load ratio (actual load P divided by the bearing's dynamic load rating C, expressed in percent). You find "dynamic C" in the bearing catalogue.

Under **EP quality,** input either the FZG no. 7 (no EP additives in the lubricant) or 12 (lubricant contains EP additives).

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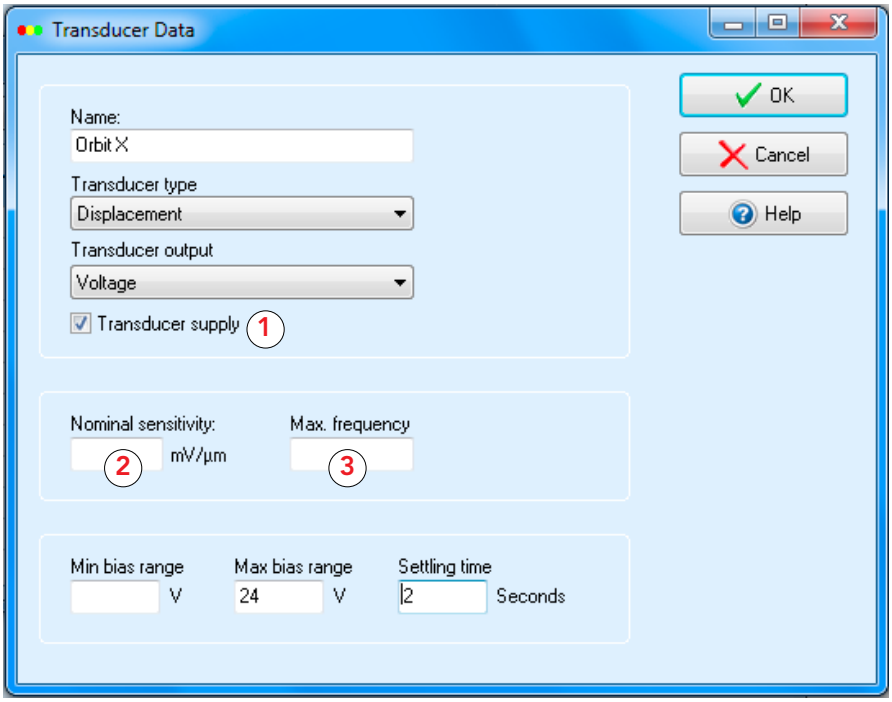

Orbit transducer setup

Orbit analysis

The vibration measurement function Orbit analysis is supported by Condmaster Nova. An orbit represents the path of a shaft centerline during rotation. The two-dimensional orbit graph is used to analyze shaft centerline movement, whih may indicate rubs, unbalance, misalignment or oil whip, in machines equipped with journal bearings.

The data required for the orbit analysis are collected by means of 1) a two channel simultaneous vibration measurement, where two displacement transducers are placed 90^{O} from each other, and 2) a trigger signal from a tachometer probe. The amplitudes of channels X and Y are plotted, resulting in a graph of the shaft centerline movement.

The displacement transducers can be substituted for accelerometers and the orbit parameters set up accordingly, in which case the measurement result is an orbit graph of machine movement.

Orbit measurement with displacement transducers requires the orbit interface 15315 to be used with Machine Evaluator. It also requires setting up two transducers particular to orbit in the transducer register. For measurement with accelerometer or velocity transducers, use the two-channel measuring cable CAB51.

Go to **System/Transducers** in the menu bar and create two displacement type orbit transducers for the X and Y axes, respectively. For an 8 mm diameter proximity probe, the **Sensitivity** (2) is normally 7,87 V/mm (7,87 mV/µm). For other probes, please turn to the TD sheet for information about their sensitivity. Enter **Max. frequency** (3) as appropriate.

When using Machine Evaluator, mark the check box **Transducer supply** (1). This will bring up additional parameter settings. Enter **Min. bias range (V)** = 0 and **Max. bias range (V)** = 24. Set **Settling time** to 2 seconds and click **OK**. If using OIS (1), the check box should normally be unmarked as the signals normally are received from buffered outputs.

In the measuring point tree, right hand click on the measuring point where orbit is to be measured and choose **Edit**. Select **Orbit** under **Available techniques** and drag it to the upper window. To the right in the **Measuring point data** form, the parameters that need to be set for orbit measurement are now displayed. Please note that only one orbit assignment per measuring point can be set up.

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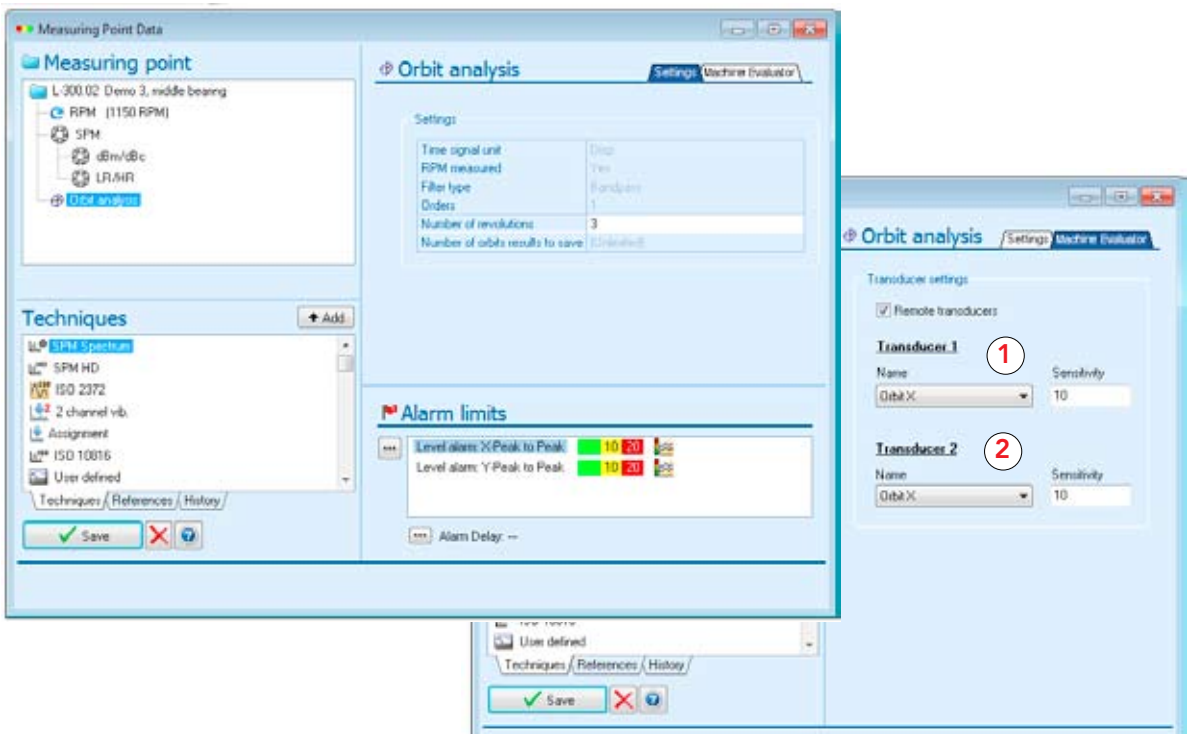

Input data for Orbit analysis

Orbit analysis, input data

Normally, **Transducer** = "**Remote"** is recommended. This means that measurement is carried out on the buffered outputs of the machine protection system, thus preventing any interference with machine operation. With a portable transducer, the transducer settings in Machine Evaluator are used instead.

In the **Transducer**: **Name** dropdown lists (1 and 2), select the "orbit transducer" previously created in the transducer register. The transducer **Sensitivity** is input in V/mm (mV/µm). With **Transducer** set to "**Portable**", this setting is not displayed.

For best results, it is strongly recommended that a measured rpm value be used in connection with orbit measurement. If rpm measurement cannot be done, enter "**No**" in the **RPM measured** field. This will bring up a new field named **RPM**, where you should input the shaft rpm value manually.

For **Filter type**, the default setting is **Bandpass**, showing frequencies at rpm ±10%. With the filter type set to **Lowpass**, all frequencies above the selected multiple of shaft speed (**Orders**, 1-5) are filtered out. The **Orders** setting is used to calculate the center frequency for bandpass mode and the upper frequency for lowpass mode, respectively.

In the **Number of revolutions** field, input the number of shaft revolutions to acquire and display in the orbit graph. **Number of orbit results to save** sets the number of orbit results saved in the database and is a means to limit database size. "**Unlimited**" means all orbit results will be saved and never overwritten.

For an evaluated measurement on the green - yellow - red scale, input **Alarm limits** for the X and Y axes according to supplier recommendations.

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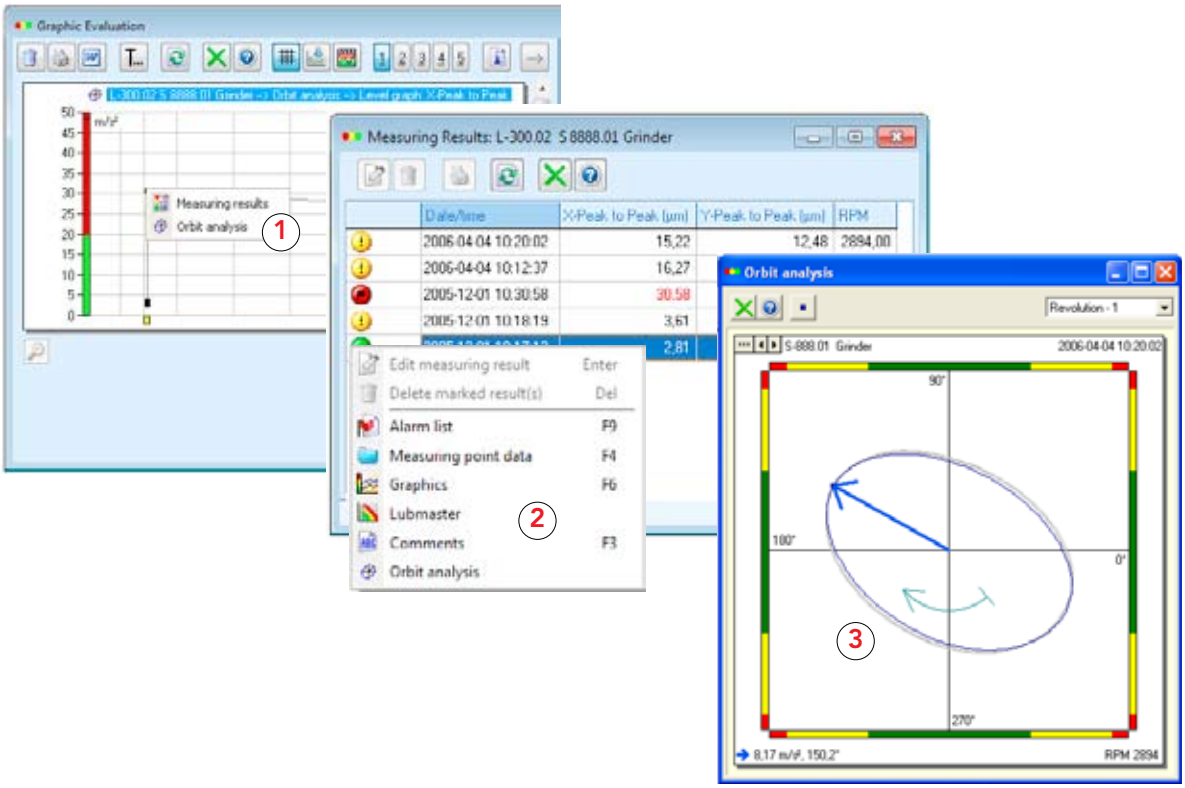

Viewing Orbit measurement results

Orbit measurement results can be accessed from the measuring point tree as well as from the Graphical Overview, using either the **Graphics** or **Measuring results** button in the toolbar.

Right clicking on a result in the Graphic evaluation window allows you to see either the orbit graph or the measuring results (1). The value showed in the Graphic evaluation is the longest vector, i.e. the largest distance measured from the orbit centre.

Right clicking on a result in the **Measuring results** window brings up a menu of options (2), allowing you to further evaluate and/or comment on the measurement.

The orbit graph (3) shows an overlay of the graphs for each measured revolution plus their average. Each individual revolution can be selected, as well as the average of all revolutions (displayed by default). The current graph is marked in blue. A blue arrow shows the angle and X/Y values at that angle. The arrow can be moved in the orbit graph using the mouse.

Right clicking in the graph displays a menu of further options.

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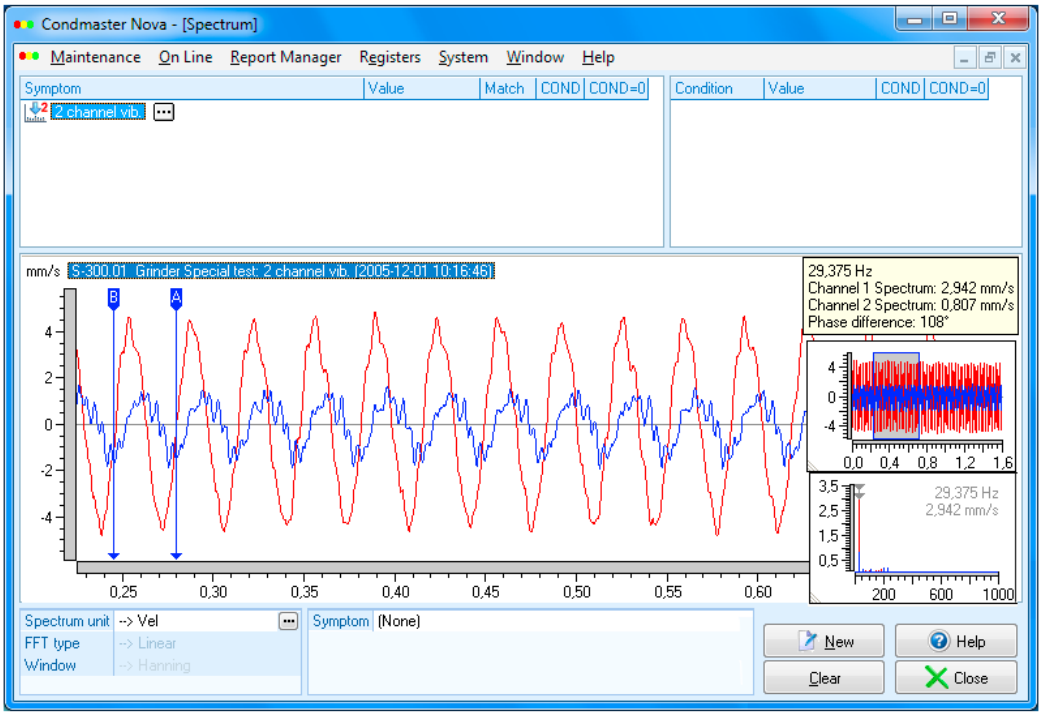

Two channel vibration spectrum with time signal

Two channel simultaneous vibration measurement

Two channel simultaneous vibration monitoring requires that either the measuring technique 'FFT with symptoms' or 'EVAM' is activated in Condmaster Nova.

With two channel simultaneous vibration measurement, machine movement can be studied in two dimensions by observing the difference between the phase angles measured on the two channels.

Measurement requires setting up two vibration assignments with identical parameters in Condmaster Nova. The two channel measuring cable CAB51 is used to connect both transducers to the Machine Evaluator transducer input.

Condmaster Nova displays the RMS values for DISP, VEL and ACC for the two channels, respectively. Three graphs are available for each measurement: spectrum, phase spectrum, and time signal.

Two markers show the difference in phase angle at the actual frequency. A phase is a time delay expressed in degrees of rotation. Machine Evaluator calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits.

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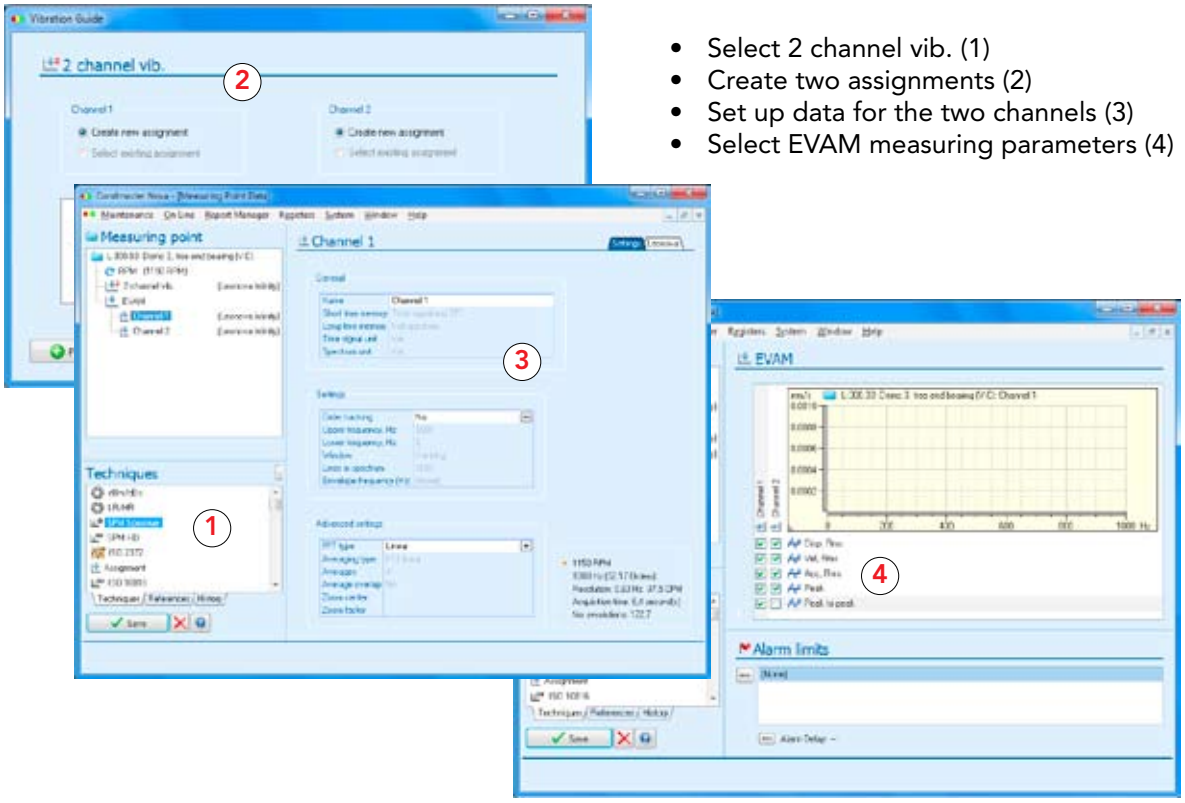

- Select 2 channel vib. (1)
- Create two assignments (2)
- Set up data for the two channels (3)
- Select EVAM measuring parameters (4)

Input data for two channel vibration measurement

To measure vibration concurrently on two channels, you must first add the technique "2 channel vib" to the measuring point and set up (at least) two measuring assignments for EVAM, preferably with descriptive names. Once this is done, the vibration guide is extended with the **2 channel vib.** option. Click this option, then click **NEXT**. The vibration guide is closed and you are returned to the **Settings** form. The only parameters to be set are **Channel 1** and **Channel 2**, which you select in the Measuring point window. Please note that the two assignments involved must have the same frequency range, transducer type and number of lines in spectrum.

The measurement procedure is the same as for the corresponding measurement with a single transducer.

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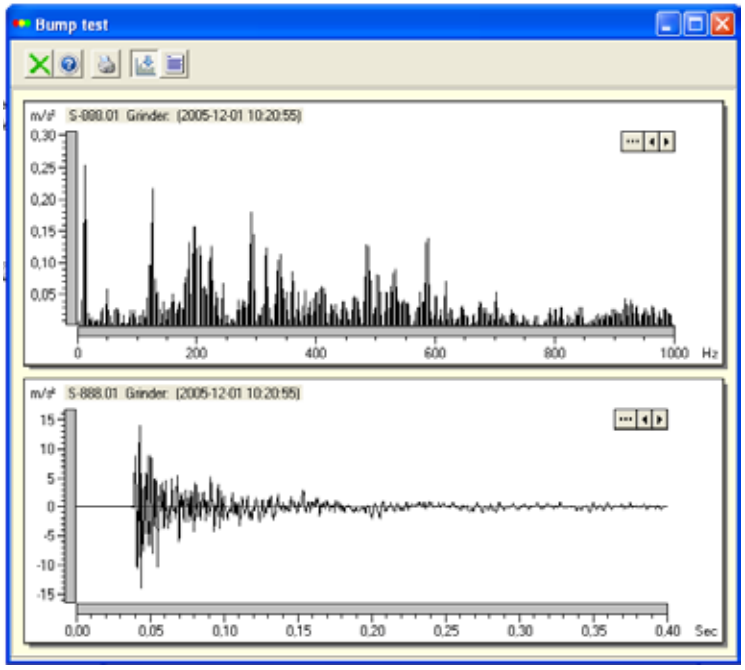

Bump test example

Bump Test

The Bump Test is a new feature in Condmaster Nova, supporting the corresponding functionality in Machine Evaluator.

A bump test is an impact test carried out on a machine that is not running in order to determine its natural (resonant) frequency. The test reveals whether resonance is the cause of high noise or vibration levels.

The natural frequency of the machine is the frequency where it starts to vibrate as a result of an impact. When this frequency coincides with that of the machine at running speed, or any other signal generated by the machine, the signals will be amplified, causing a higher than normal vibration level which may ultimately cause machine damage or failure.

If the natural frequency is at or close to the normal running speed, steps should be taken to change this frequency.

To start using Bump Test, a **Bump Test** comment must first be defined under **Registers/Standard Comments**. Once the comment is created, its code and color can be edited. Add the comment to the desired measuring point, create a round and download it to Machine Evaluator. The parameters for bump test are set in the instrument, then uploaded to Condmaster where the measurement results can be found under **Comments** for the measuring point in question.

To see a bump test result, mark the measuring point in the **Measuring point tree**, then click on the button **Comments** in the tool bar. In the **Comments** window then displayed, double click on the comment to see its data and edit them if required. To see the bump test diagram, click on the button **Bump test** in the **Comments** window tool bar. The diagrams are also available via the **Edit** function when viewing comments in graphs etc.

The natural frequency is the highest line in the spectrum. With a right hand click on the spectrum, it can be stored as reference spectrum for any measuring assignment.

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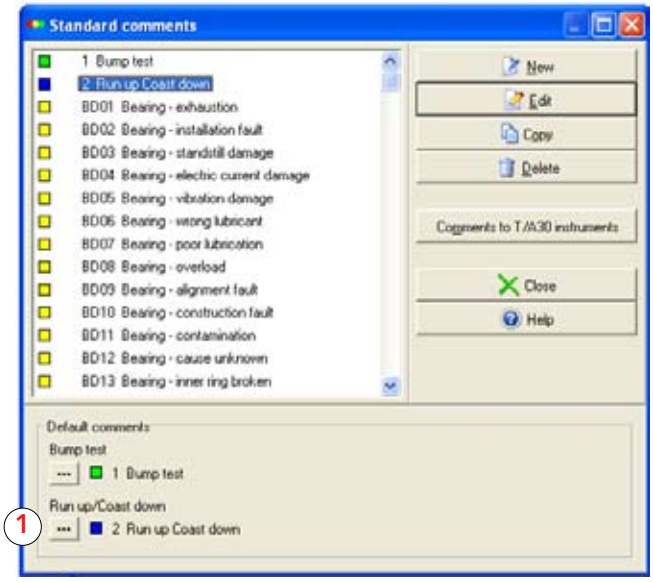

Set up a Run up/Coast down comment in **Standard comments**:

- Create a new standard comment and name it e.g. "Run up/Coast down".
- Click the "..." button under **Run up/Coast down** (1) to assign a default comment to it.

Run Up and Coast Down measurements

Like the Bump test, run up and coast down measurements are methods for resonance testing, available with the Machine Evaluator.

During run up and coast down, machines go into resonance once a certain speed is reached. This speed is known as the *critical speed*. The critical speed depends on a number of variables, such as shaft diameter and length and how the shaft is supported. Operation at or near critical speed should be avoided because vibration will increase and may build to unsafe levels. Please note that machinery may have multiple resonance frequencies.

Normally, rotating machinery operate above their critical speed. Therefore, the rotor must pass through its critical speed(s) during run up and coast down. Time spent within the critical speed ranges should be kept to a minimum. If the run up or coast down process is too slow, the machine may be subject to excessive vibration. The critical speed range(s) should be passed as quickly as all concerns allow.

Passing through critical speed is usually safe, provided there are no excessive exciting forces such as unbalance or misalignment, and damping is sufficient. However, some damages may cause the critical speed to shift closer to the normal operating speed of the machine. This is a condition to be watchful of, as normal running speed must be sufficiently far from the critical speed. If the critical and running speeds should be close with no present damage, stiffening the structure e.g. may solve the problem.

To start using Run up/Coast Down, a **Run up/Coast Down** comment must first be defined under **Registers/ Standard Comments**. Once the comment is created, its code and color can be edited. Add the comment to the desired measuring point, create a round and download it to the Machine Evaluator. The parameters for Run up/ Coast Down are set in the instrument, then uploaded to Condmaster where the measurement results can be found under **Comments** for the measuring point in question.

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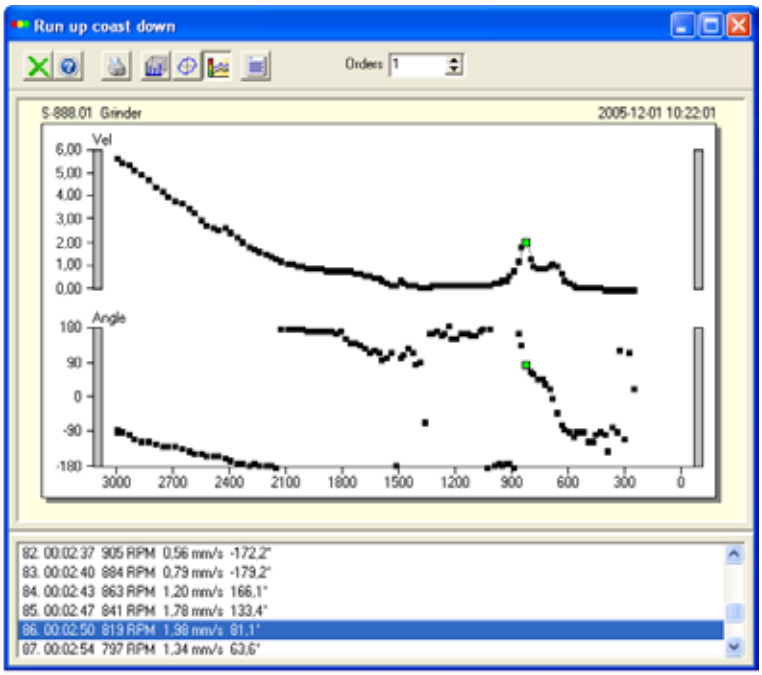

Run up/Coast down example

Working with the Run Up and Coast Down results

To see a run up/coast down result, mark the measuring point in the **Measuring point tree**, then click on the button **Comments** in the tool bar. In the **Comments** window then displayed, double click on the comment to see its data and edit them if required. To see the run up/coast down diagram, click on the button **Run up/Coast down** in the **Comments** window tool bar. The diagrams are also available via the **Edit** function when viewing comments in graphs etc.

Three types of diagrams can be viewed:

- **Waterfall diagram**, displaying the current diagram in blue. Mark a measuring result, then the arrow keys on your keyboard can be used to step between diagrams. With a right hand click on the waterfall diagram, it can be stored as reference spectrum for any measuring assignment.
- **Nyquist diagram**, showing the phase angle and amplitude in a single diagram, with the current diagram in blue. A phase is a time delay expressed in degrees of rotation. The Machine Evaluator calculates the time delay between the passage of the tachometer pulse and the peak of the frequency component of interest from the vibration transducer at the speed of rotation. The value presented is a relative angle, not an absolute, because there is no compensation for phase lag in the transducer or the electronic circuits. In the Nyquist diagram, RPM is displayed in the list of measurements only.
- **Bode diagram** showing two separate diagrams with vibration amplitude (DISP, VEL or ACC) and phase angle on the Y axis, respectively, and RPM om the X axis. All measurements are displayed in time sequence. The current measurement is shown in green.

In all diagrams, a green dot shows the position of the measurement marked on the list.

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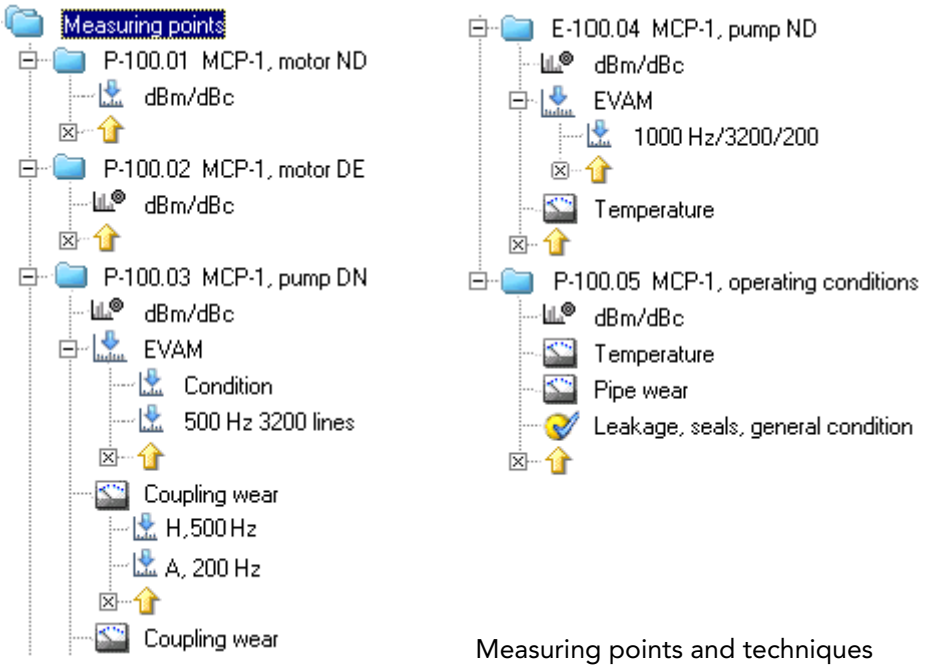

Measuring points and techniques

Measuring techniques in the tree structure

To see all measuring point data for the component, go to the tree structure. Double click on all measuring point folders belonging to the new component. Each measuring technique is shown as a symbol. If it is marked with a "+", you can click it open to see further details.

From there, you can go directly to any technique form. Mark the measuring point folder and press **ENTER** (hop to the main data form of the measuring point), or mark the measuring technique and press **ENTER** (hop to the marked measuring technique).

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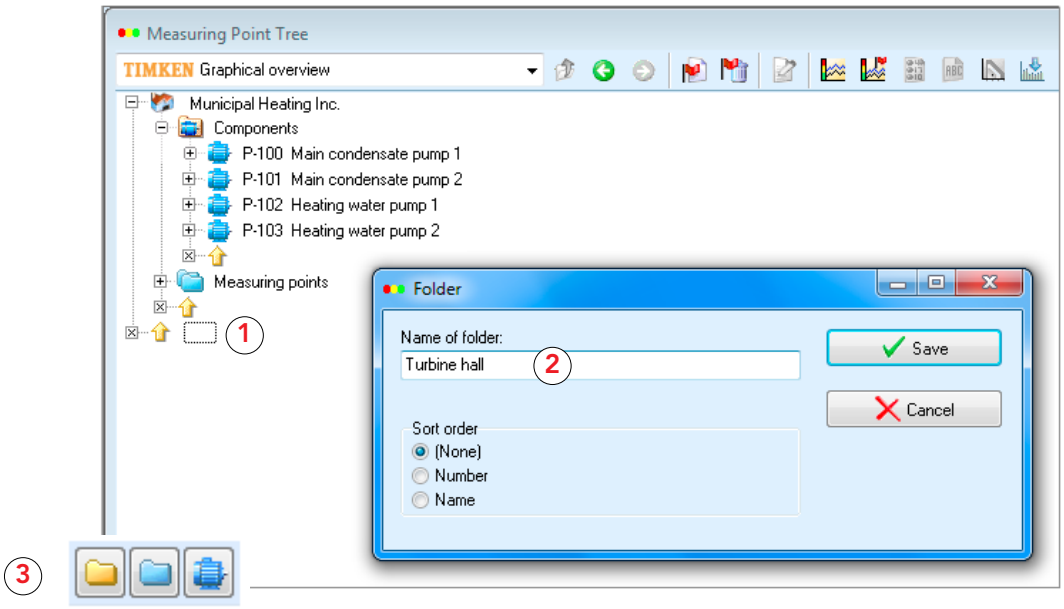

Create your own folder:

- Click on the arrow beneath the Measuring point folder (1), press F5 (or click on the yellow folder icon).
- Name the folder and click **OK** (2).

Making your own folder

After copying and editing the first component three times, the component folder contains four machines. All their measuring points are in the measuring point folder. Both folders are sorted alphabetically by number.

You do not have to change this simple tree structure. However, building your own tree structure beneath these permanent folders has many advantages and does not take much time. The idea is to sort your machines by either location and/or production process, to give you a easy to grasp overview over the monitored parts of the plant, and a fast means to create measuring rounds.

Your first own folder is placed beneath the standard structure. Click on the arrow (1) to mark it, then press F5 for "new folder" (or click on the yellow folder icon, bottom left). Input the folder name and click **OK** (2).

Your other alternatives are to mark the folder position as above and either

- click with the right hand mouse button and select **Create** and **Folder**, or
- click on the yellow **Create (folder)** icon (3) in the lower left hand corner of the screen.

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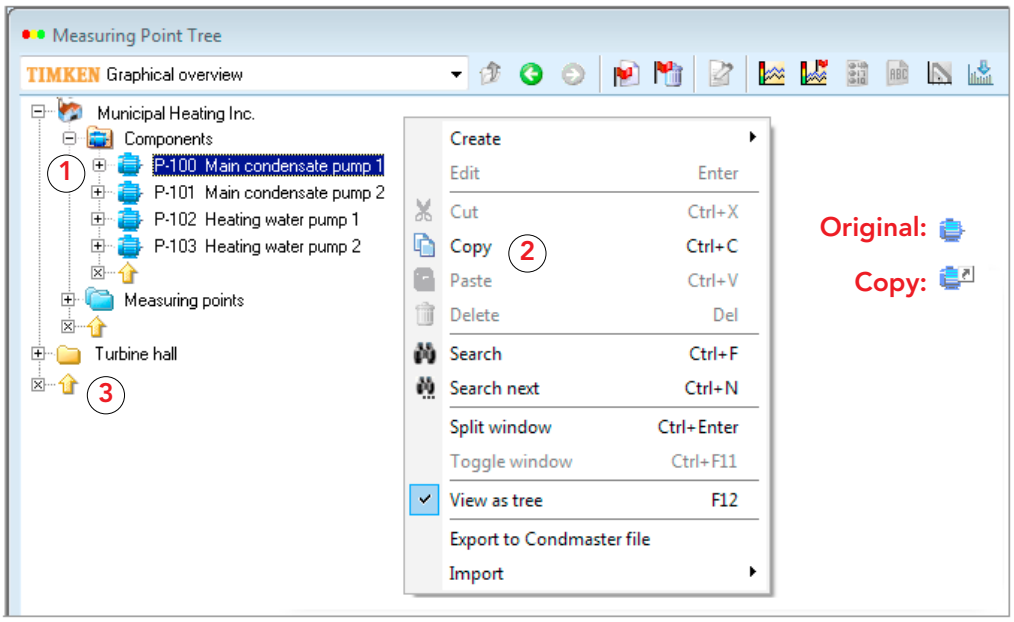

Copy to folder:

- Mark the component (1), press right the hand mouse button, select **Copy** (2).
- Mark the arrow beneath the folder (3), press the right hand mouse button, select **Paste**.

Copy alias via clipboard to folder

To put machines into your folder, you copy a component to the clipboard, then paste it into the previously created folder.

The original component remains inside the standard component folder. Your own folder contains an alias, recognizable by an arrow on the icon. When you edit the alias, the original is also edited automatically. Deleting the alias will not affect the original.

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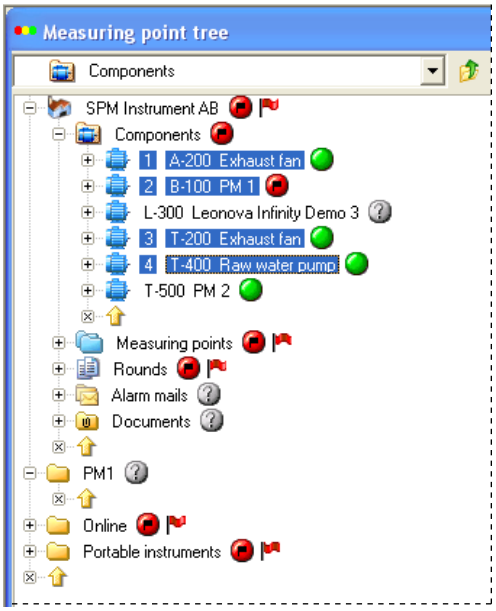

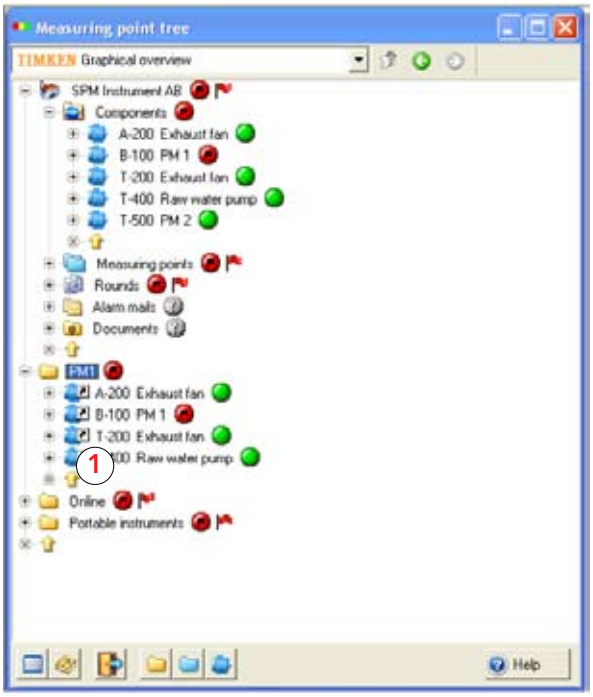

Copy a group in round order:

- Hold down CTRL, mark components in desired sequence, press CTRL+C.
- Mark the arrow beneath the destination folder (1), press CTRL+V.

Copying in round order

Holding down CTRL while clicking on the components allows you to mark a whole group in any order. If you mark them in round order (the sequence in which they are to be measured), you can later place your own component folder into a measuring round, without making any changes.

To mark a group of items, you can also click on the first, then hold down the SHIFT key and click on the last item in the group.

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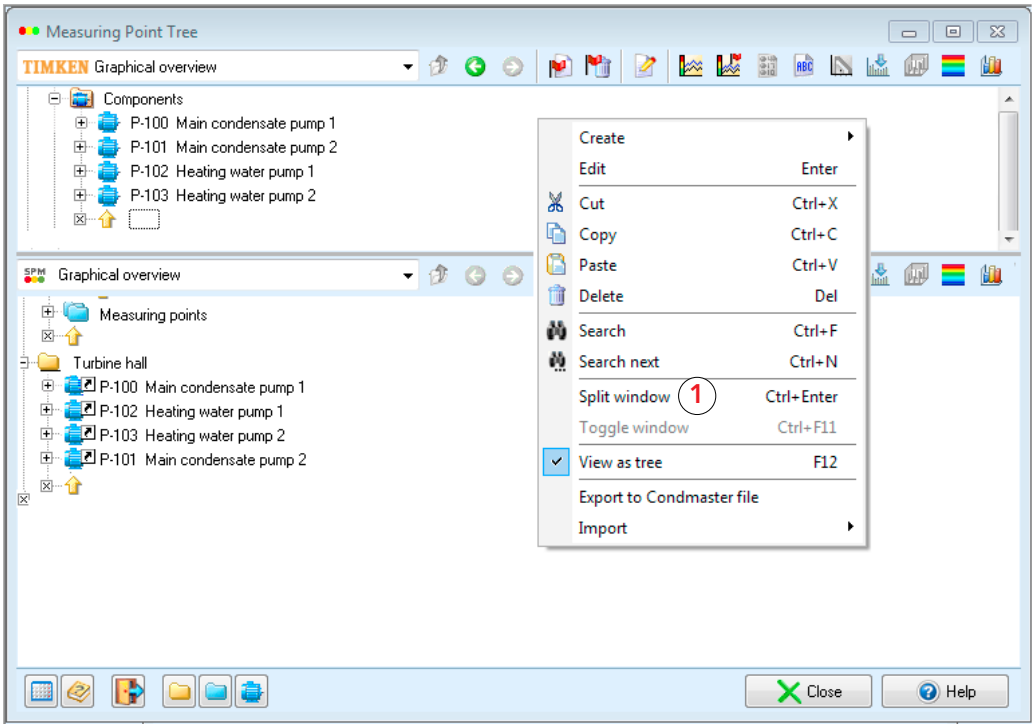

Select Split window (1).

Working with a split window

The standard component folder will soon contain many items. Instead of scrolling up and down between this folder and your tree structure, you can split the window and scroll each part to the desired position.

Please note that each item you create or paste is inserted **above** the marked position. Thus, if you mark a folder, the components in the clipboard will be pasted in outside of and above this folder. To get it inside, you must open the folder and mark the arrow beneath the last item or any of the items inside.

You cannot drag items within the tree structure unless you split the window. To move them to another position, use **Cut to clipboard** (CTRL+X), then paste them into the desired place (CTRL+V).

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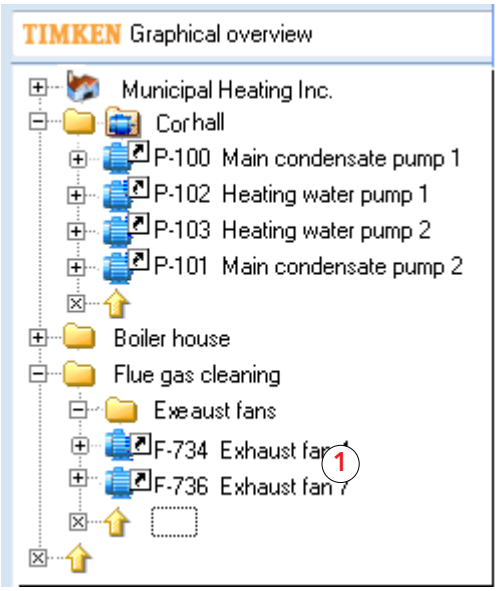

Tree structure:

- Folders can be inside other folders.
- Components/measuring points can be created inside your own folders.

Working inside your own folders

Instead of creating components in the standard component folder, you can make your own tree structure first and create them inside your own folders. This will place aliases in your folders and automatically put the originals in the standard component folder.

Folders can be put inside other folder, extending the structure sideways (1).

It is also possible to use measuring point folders instead of components. This saves you the trouble to create components. The disadvantage of this procedure is that you do not have a machine unit with which you can connect work descriptions or comments concerning the whole machine.

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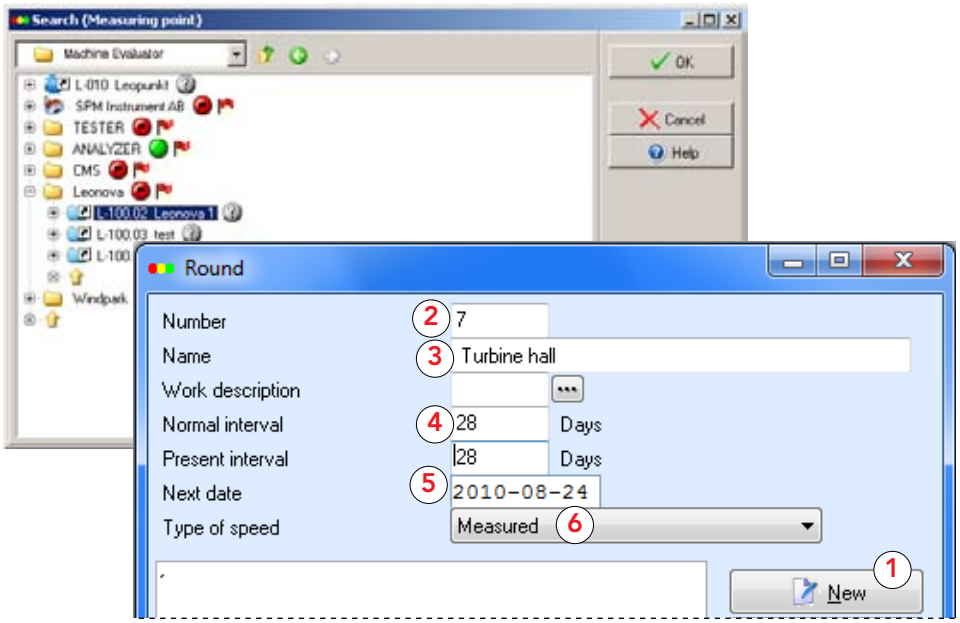

Creating a measuring round 1:

- Right hand click in the Measuring point tree, select **Create** and **Rounds**. Click **New** (1).
- Input number (2), name (3), normal interval (4), next date (5).
- Select type of speed (6).

Creating a measuring round

For data loggers you must create measuring rounds (or standard work orders) to be able to load the instrument. To create a round, right hand click in the Measuring point tree, select **Create** and **Rounds**.

On the round form, click **NEW** (1) to obtain the data input form. Rounds are numbered from 1 to 9999 (2). They are also named (3), e. g. with the name of the folder where you store the measuring points.

"Normal interval" is the time between measurements in days. **Present interval** is automatically set to the value under **Normal interval**. This is the value you edit when you want to make a temporary change in the measuring interval. For example, to measure once a week (to check on the deterioration rate of a bad bearing), you would set **Present interval** to 7 instead of the normal 28.

Next date is the day you plan to take the reading. Condmaster Nova sets a new next date when you upload your readings to the PC, by adding the number of days under **Present interval** to the uploading date. Thus, to keep your time plan in order, always measure and upload as planned.

Speed can be either "measured" (you measure with the tachometer probe in connection with the condition measurements) or "constant/preset". Constant speed is the speed value stored in the measuring point register. Preset speed is input while you download the round.

"Work description" is an option: you can input the code of a previously created work description and connect it to the round.

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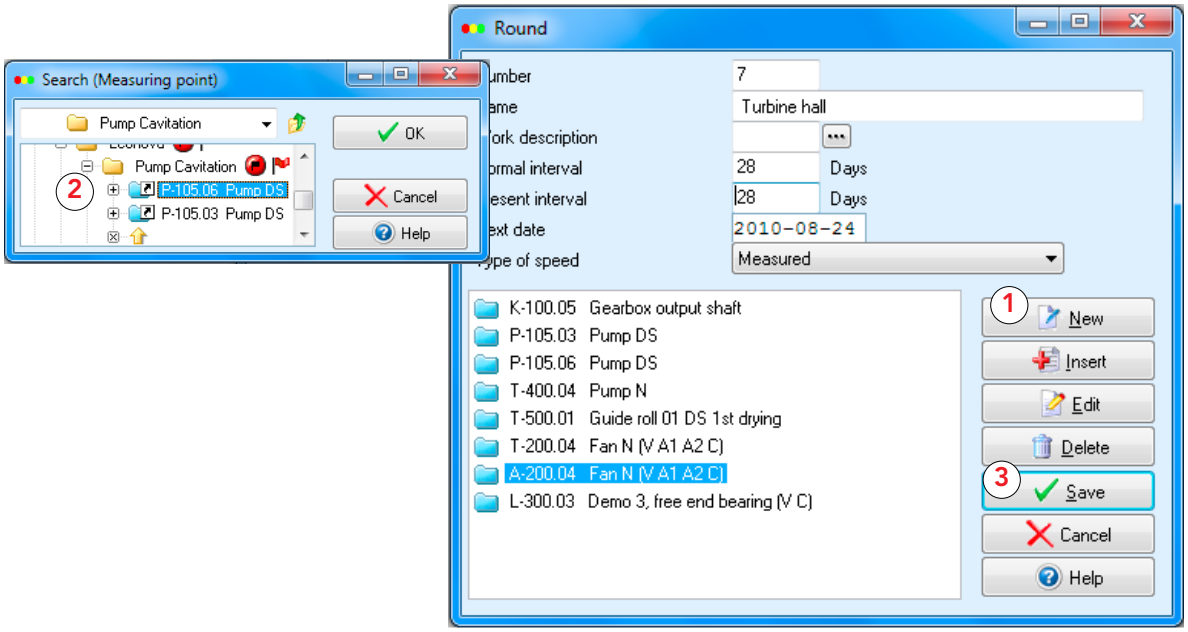

Creating a measuring round 2:

- Click **NEW** (1) on the data input form.
- In the measuring point tree (2), mark an item and click **OK**.
- Click on **SAVE** (3).

Entering measuring points into a round

Clicking **NEW** (1) on the data input form opens the measuring point tree. Any item in the tree can be selected to be included in the round. If all measuring points intended for the round are in one folder in the measuring point tree, and in the right order, you simply mark the folder and click the **OK** button below the tree to transfer the lot to the round.

Clicking **NEW** again allows you to add more measuring points at the end of the round. You can also mark a measuring point in the round and then use **INSERT** to add other points above the marked point.

To delete a measuring point from a round, mark it and click the **DELETE** button. Two or more consecutive measuring points may be marked by holding down the SHIFT key and clicking on each row in turn.

When you mark a point and click **EDIT**, you replace this point with your selection from the tree. To finish, click **SAVE**.

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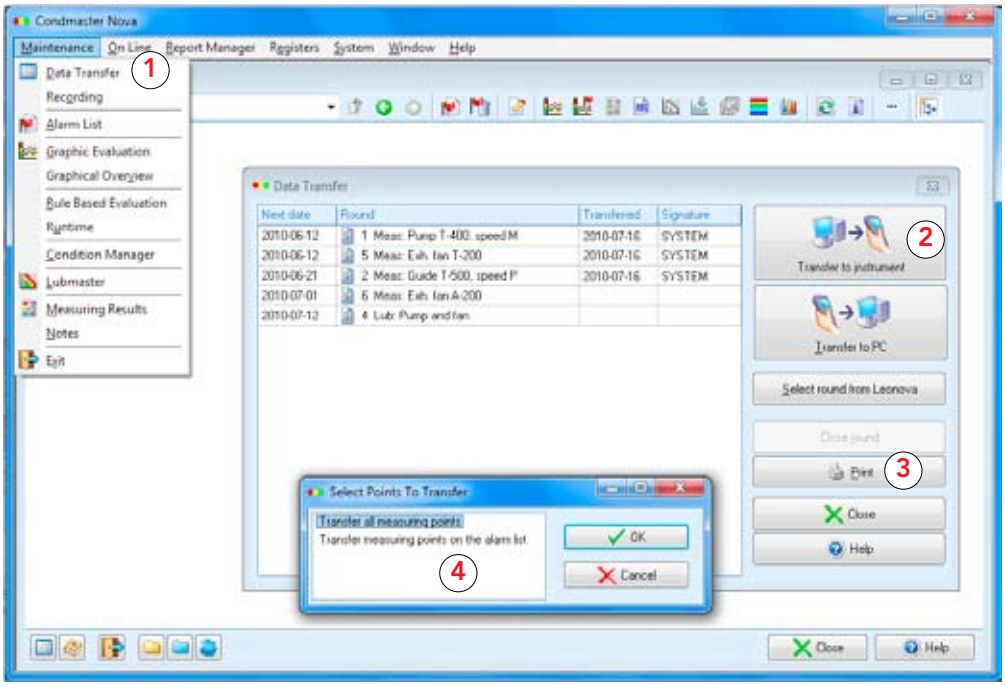

Downloading a round:

- Open **Data transfer** (1) under **Maintenance** in the menu bar.
- Mark the round, click **Transfer to instrument** (2).

Download round to instrument

To download a round to a data logger, select **Data transfer** under **Maintenance** (1) in the menu bar, then click **Transfer to instrument**.

With **Print** (3) you can print out the measuring points in the round and work descriptions (4) via the **Report Manager** (see later in this manual).

Normally, you will select **Transfer all measuring points**. The second alternative, measuring points on the alarm list, is used when you want to make a second check on the measuring points with high readings. It loads the measuring points which are both on the alarm list and in the present round.

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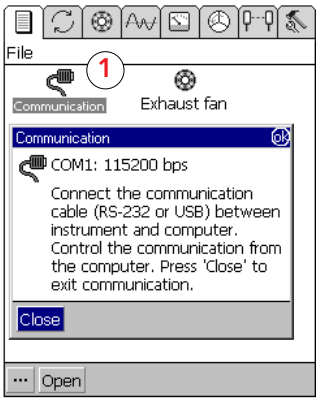
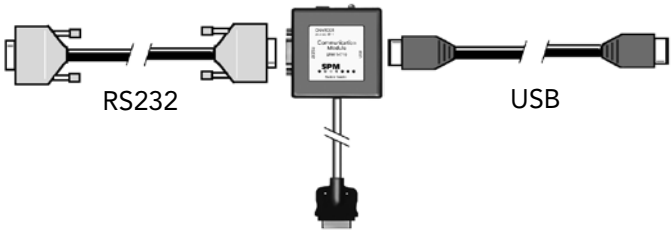
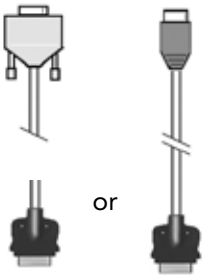


Machine Evaluator:



Machine Evaluator:



Connect the Machine Evaluator to a PC:

- Connect to port, start "Communication"(1)
- Click **OK** (2)

Connecting the Machine Evaluator to a PC

To transfer, connect the Machine Evaluator to the COM or USB port registered under **Measuring system** in the menu bar. Select **Communication** (1) on the Machine Evaluator **FILE** menu. The instrument screen reads "**Ready for transfer.**" Click **OK** on the PC screen (2).

The round appears as a file on the Machine Evaluator **FILE** menu. Measuring points and techniques come up on the instrument screen in round order.

You get an error message if anything is wrong with the data transfer. Normal reasons for communication errors are:

- The downloaded round does not contain a Machine Evaluator measuring point.
- The communication port set on Machine Evaluator is not the as the port set in Condmaster.
- Machine Evaluator is connected to the wrong communication port.

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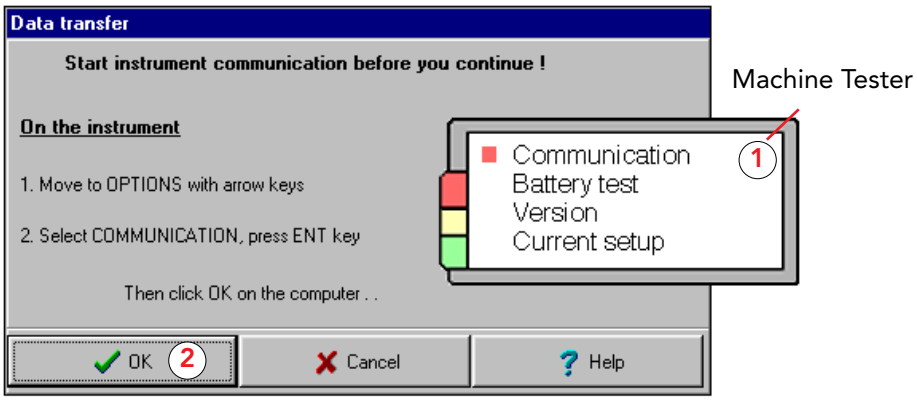

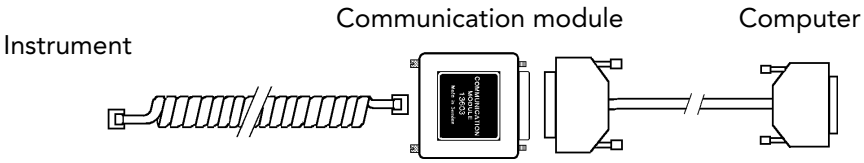

Connect Machine Tester to PC:

- Connect to COM port, start and switch to "Communication" (1)
- Click **OK** (2)

Connecting Machine Tester to PC

To transfer, connect the data logger to the COM port registered under **System/Measuring system**. For computers with USB ports only, a USB to RS232 converter is needed.

Select **Communication** (1) on the instrument screen and press the **ENT** key. The instrument screen reads "Ready for transfer." Click **OK** on the PC screen (2). An error message is displayed if anything is wrong. After successful data transfer, the last line on the instrument screen reads "Finished".

Measuring points and techniques come up on the instrument screen in round order. Normally, you complete the measuring round before uploading results. You can upload a partly finished round and download the remaining measuring points later, using the alternative "Measuring points without results".

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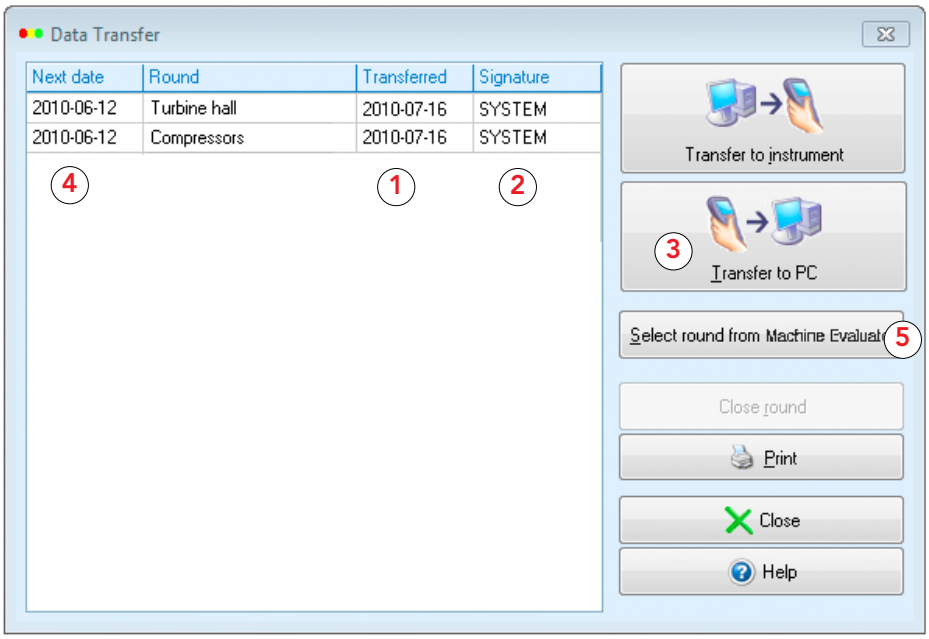

Upload results to PC, close round:

- Connect instrument to the PC port, switch to **Communication**.
- Click **Transfer to PC** (3).

Uploading results to the PC, closing the round

After downloading a round, the transfer form shows the downloading date (1) and the signature used to open Condmaster Nova when the round was downloaded (2). Thus you can keep track of the rounds which are currently being measured and of the personnel working on them.

To upload results you use the same procedure as for downloading, but a different button: **Transfer to PC** (3). When the uploaded round is complete (all points measured) it is automatically closed. This removes the transfer data and sets a new due date under **Next date** (5). For an unfinished round you get a reminder that measurements are missing. You can close the round anyway and finish it and transfer the rest later.

The button **Select round from the Machine Evaluator** (5) allows you to transfer any Machine Evaluator file to the PC, provided it only contains measuring points that are set up in your Condmaster.

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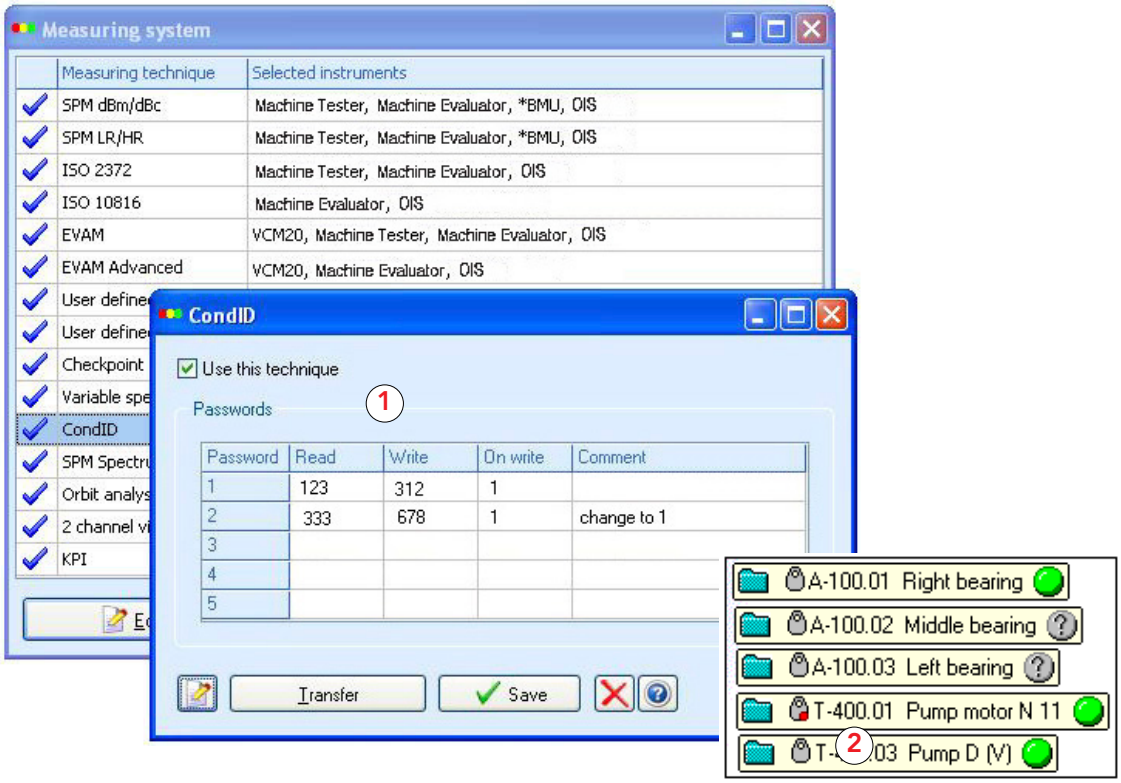

Identification tag Cond ID™ in Condmaster

When the instruments are loaded with measuring points from Condmaster Nova, the program will automatically send all necessary codes. For an open system without password there is no setup for tags. For a system with the extra password protection, you have to input the passwords. Everything else is an automatic part of the downloading procedure. A identification tag is ready for reading/writing when the box **Use this measuring technique** (1) is marked.

You can use all available measuring techniques together with the tags, checkpoints included. They are initiated through a first WRITE command. The measuring points must then be uploaded to Condmaster Nova.

In the measuring point tree, ”tagged” measuring points are marked by the tag icon. If it shows a red dot (2), the tag memory could not accommodate all data. In such a case, data will be left out. This starts with shortening the measuring point name. Next, the checkpoint text is shortened/left out, then others, working rear to front. The ID tag menu will show the used number of bytes (one byte = one character).

In case of memory trouble, edit the measuring point. You may be able to cut down on redundant information:

- Use short measuring point names and short texts for ”checkpoints”.
- Define **Measured quantity** for **User defined** with as few characters as possible. Keep the result display format ”##.#” to the minimum.
- Distribute the measuring techniques to two measuring points if necessary.

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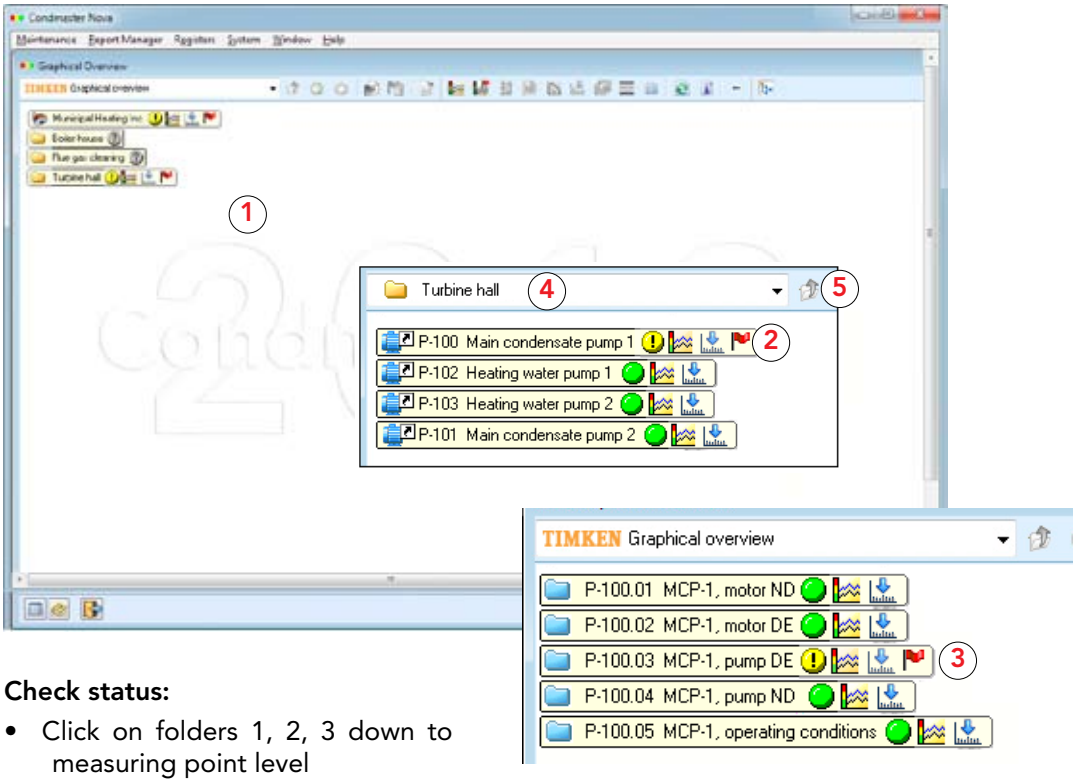

Check status:

- Click on folders 1, 2, 3 down to measuring point level

Status display in the Graphical Overview

Once there are measuring results stored in Condmaster Nova, the Graphical Overview provides a status display, based on the latest measuring results and showing the condition of the **worst** measuring point inside a folder by a colored dot:

- green: all evaluation results inside the "good condition" limits, or only raw values inside the folder (no evaluation)
- yellow: at least one evaluation result inside the "caution" limits
- red: at least one evaluation result inside the "bad condition" limits
- grey with question mark: no measuring results or alarm levels inside the folder.

A red flag after the status dot shows that at least one measuring point inside the folder is presently on the alarm list. The red flag can turn up in connection with a grey or a green dot when the measuring point has been forced on the alarm list with a comment. Clearing the alarm list removes the flag.

For details, you click on the folders you want to look at (1, 2, 3) and work your way downwards to the measuring point level (see next page). Your position in the tree structure is shown by the title of the open folder (4). Clicking on the folder icon (5) next to the folder title takes you one step upwards in the tree structure.

At the measuring point level (3), you can click on the status dot to get a display of the latest measuring result (see next page). Right hand clicking on a status dot, at any level, gives a jump to Graphic evaluation.

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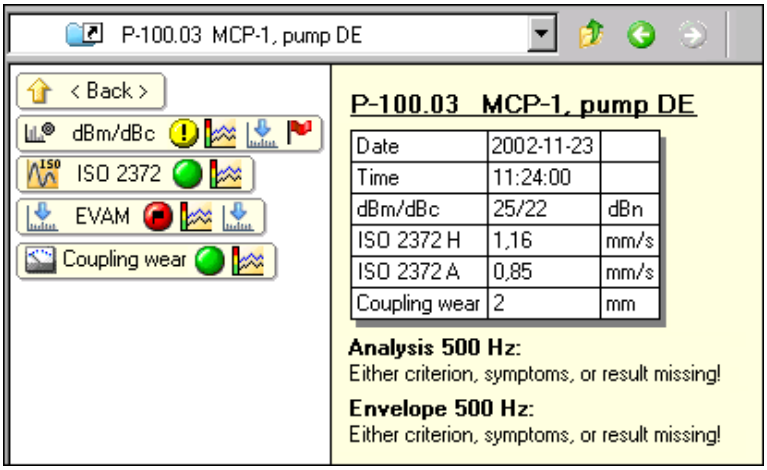

Measuring point status:

- Measuring techniques listed with status dot (and alarm flag)
- Measuring results with time and date

Status display for measuring techniques

At the technique level, you see all active measuring techniques and the status based on the latest measuring results. In this example, the yellow dot is on the shock pulse reading.

EVAM measuring results are only displayed if they are evaluated by means of a so-called criterion, else you see the message "Either criterion, symptoms, or result missing" under the assignment name. If there is no result, the EVAM dot is greyed out. Missing symptoms means that all condition and symptom parameters were deactivated in the measuring point register. In this case, the criterion is missing, because it has not yet been defined. One EVAM reading is not enough for making a criterion, you need a whole batch of readings (please see under "Uploading results to the PC, closing the round" in chapter "Measuring Rounds").

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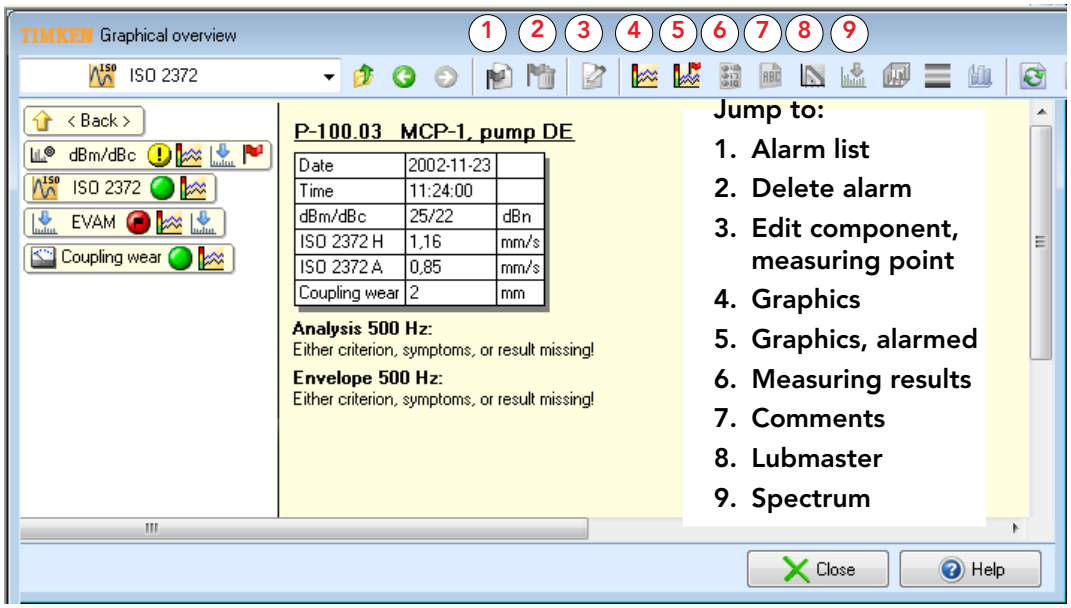

Jumps from **Graphical Overview**

Evaluation functions from the Overview

From the **Graphical Overview** you can jump to all other functions you might need for a more detailed evaluation of machine condition by clicking on the buttons at the top of the screen.

Two of these button are connected with a measuring technique. The **Lubmaster** button (7) is only active when you have marked an item containing a LR/HR measuring point (or the LR/HR measuring technique itself).

The **Spectrum** button (8) leads to **Compare spectrum** when an item containing several EVAM assignments is marked. With **Compare spectrum** you can display the spectra from several assignments, which can belong to different measuring points or components.

When marking a single EVAM assignment (click on EVAM in the display shown here to go down to the assignment level), the spectrum button leads to the function **Spectrum**.

The alarm button (1) opens the alarm list for the marked item on the **Graphical Overview**.

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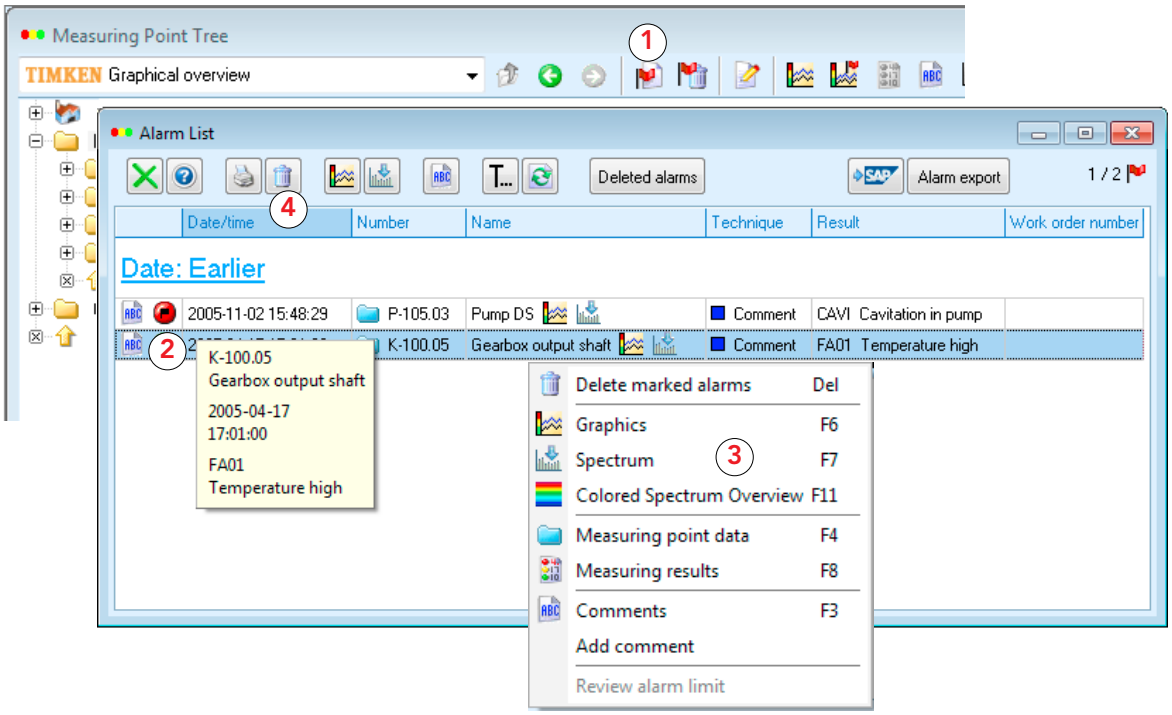

- Open the **Alarm list** (1)
- Click on the flag (2) for data. Right hand click on item for jump menu (3)
- Click on bin (4) to delete marked item.

Alarm list

The alarm list is connected to the alarm limits set as part of the measuring point data. If you do not set alarm limits, the measuring point will not appear on the alarm list, even when the evaluation result indicates that machine condition is bad.

Clicking on the alarm flag (2) of an item displays all its measuring results. Values causing alarm are marked in red. When possible, the evaluation result is shown as a colored square. It is also shown as a status dot on each line.

Only the first alarm on a measuring technique will appear on the alarm list. If later measuring results also exceed the same alarm limit, they will be marked red in the measuring result register, but the alarm will not be repeated on the alarm list. To get "fresh" alarm messages, you should delete the alarm from the list once you have noted its presence, investigated its cause, and taken the necessary steps to repair or monitor the fault.

After uploading a measuring round to the PC, you can download all measuring points on the alarm list to the data logger and measure these points again, to make sure the alarm is not due to a measuring fault.

Right hand clicking on an item opens a menu (3) with jumps to other functions. For LR/HR points there is also a jump to Lubmaster.

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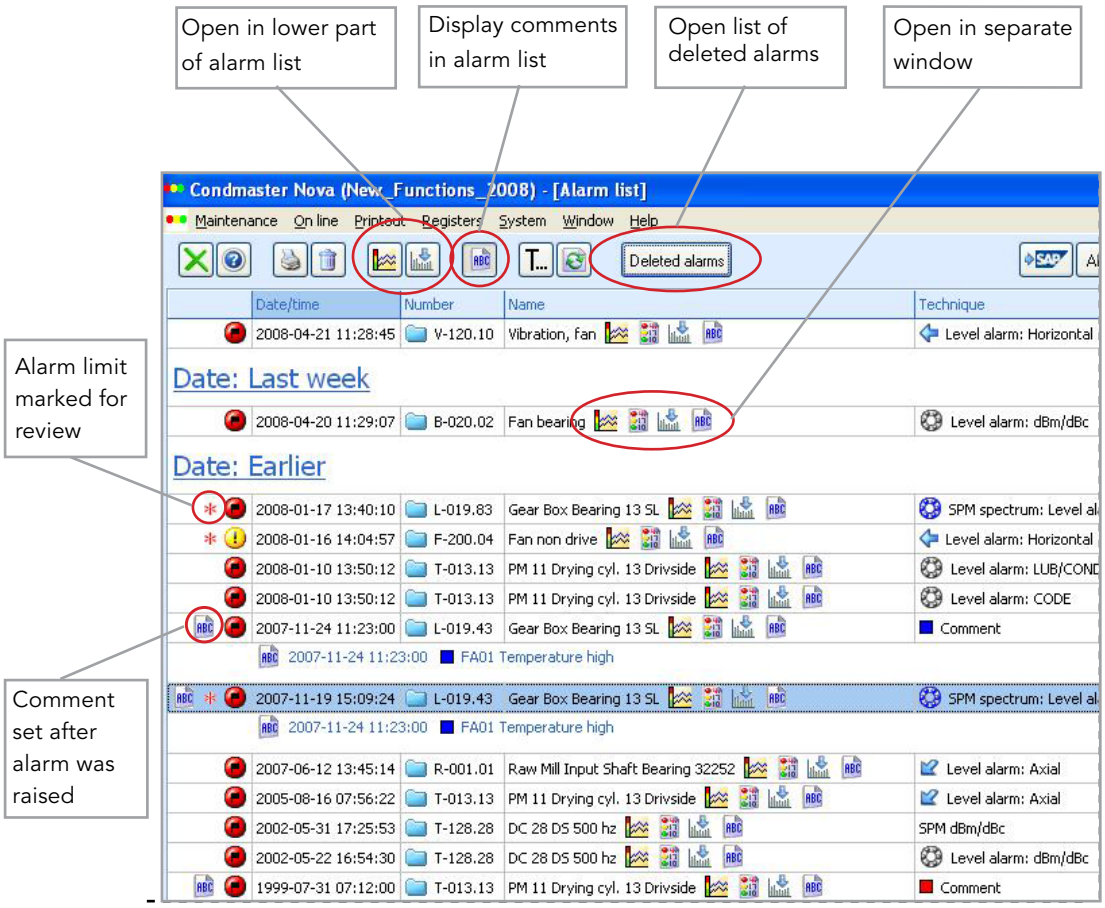
Open in lower part of alarm list
Display comments in alarm list
Open list of deleted alarms
Open in separate window
Alarm limit marked for review
Comment set after alarm was raised
Condmaster Nova (New_Functions_2008) - [Alarm list]
Maintenance On line Printout Registers System Window Help
Deleted alarms
Date/time Number Name Technique
2008-04-21 11:28:45 V-120.10 Vibration, fan Level alarm: Horizontal
Date: Last week
2008-04-20 11:29:07 B-020.02 Fan bearing Level alarm: dBm/dBc
Date: Earlier
2008-01-17 13:40:10 L-019.83 Gear Box Bearing 13 SL SPM spectrum: Level al
2008-01-16 14:04:57 F-200.04 Fan non drive Level alarm: Horizontal
2008-01-10 13:50:12 T-013.13 PM 11 Drying cyl. 13 Drivside Level alarm: LUB/COND
2008-01-10 13:50:12 T-013.13 PM 11 Drying cyl. 13 Drivside Level alarm: CODE
2007-11-24 11:23:00 L-019.43 Gear Box Bearing 13 SL Comment
2007-11-24 11:23:00 FA01 Temperature high
2007-11-19 15:09:24 L-019.43 Gear Box Bearing 13 SL SPM spectrum: Level al
2007-11-24 11:23:00 FA01 Temperature high
2007-06-12 13:45:14 R-001.01 Raw Mill Input Shaft Bearing 32252 Level alarm: Axial
2005-08-16 07:56:22 T-013.13 PM 11 Drying cyl. 13 Drivside Level alarm: Axial
2002-05-31 17:25:53 T-128.28 DC 28 DS 500 hz SPM dBm/dBc
2002-05-22 16:54:30 T-128.28 DC 28 DS 500 hz Level alarm: dBm/dBc
1999-07-31 07:12:00 T-013.13 PM 11 Drying cyl. 13 Drivside Comment

Working with the alarm list

The alarm list contains several functions:

- The list is divided into sections relating to the alarm date: *Today*, *Yesterday*, *Last week*, *Last month*, *Earlier*
- Deleted alarms, including the signature of the user responsible for deletion, can be viewed via the **Deleted alarms** button.
- When clicking the **Graphics** or **Spectrum** buttons in the **Alarm list** tool bar, a graph is shown in the lower part of the alarm list, also displaying a red marker line indicating what reading caused the alarm. Clicking the **Graphics** or **Spectrum** icons on the row of an individual alarm opens **Graphic evaluation** or **Spectrum** in separate windows.
- A red asterisk signifies an alarm which has been marked for review or follow-up. Marking an alarm limit for review is done from the **Measuring Point Data** form.
- The Alarm flag symbol is removed from the list - all entries are alarms by definition.
- A **Comment** icon ("*ABC*") in the leftmost column means a comment has been set after the alarm was raised.
- Alarms may be generated also from the OIS Commander Units, e.g in case of communication malfunctions.

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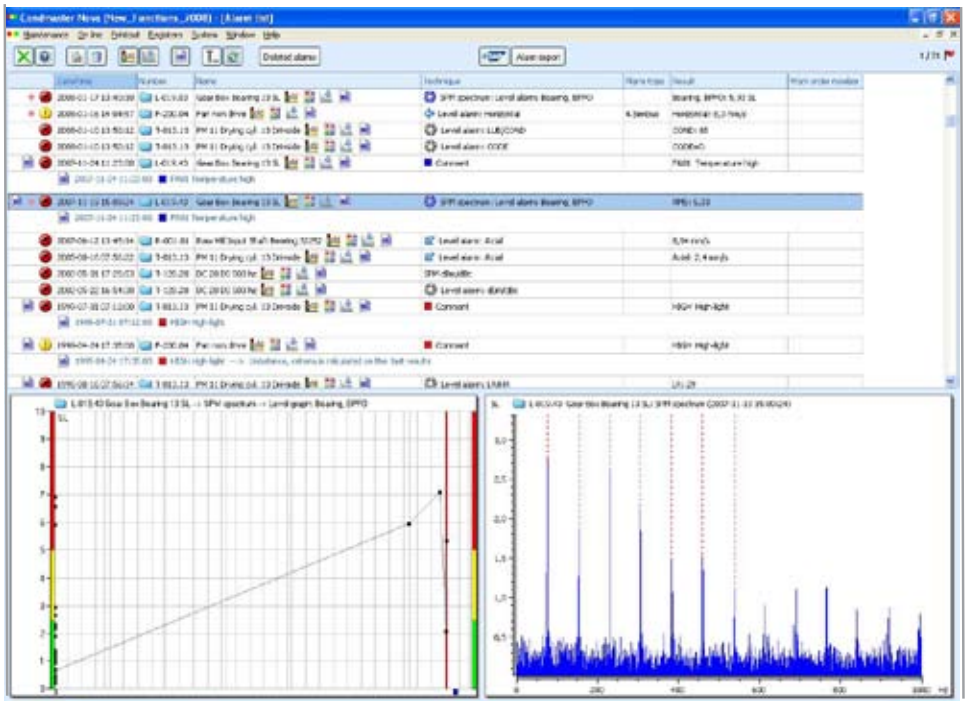
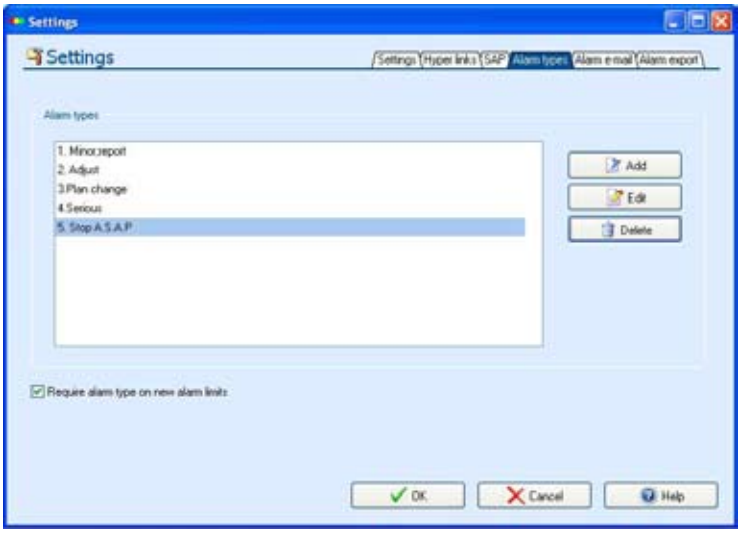


An example of the alarm list displaying graph and spectrum in the bottom half of the window. There is no zoom or "right click functionality" in this display

Alarm type

Alarm types can be used to classify the severity of alarms. For production personnel or similar, alarm types may serve as a guide on what to do when an alarm is raised. Alarm types are displayed on the alarm list, and sorting the list on the **Alarm type** column is a handy way to keep check of alarm severity so the right prioritization decisions can be made.

Alarm types are created under **System** > **Settings** > **Alarm type** tab. Tick the **Require alarm type on new alarm limits** check box to force the selection of an alarm type before a new alarm limit can be saved (optional).



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Alarm Limit Manager

The **Alarm Limit Manager** is a new feature in Condmaster, presenting an overview of existing alarm limits. This is a convenient tool to verify that alarm limits are in fact set up for your measuring points and that they are viable and reasonable. The Alarm Limit Manager is accessed via the "**...**" button in the Condmaster toolbar after you've marked a folder or measuring point in the measuring point tree.

- To view a graph of any of the measuring points in the **Alarm Limit Manager** window, mark one and click the **Graphics** button in the toolbar. The graph is then displayed at the bottom of the Alarm Limit Manager window. To open a graph or spectrum in a separate window, click the **Graphics** or **Spectrum** icon on the row of an individual measuring point.
- The **Edit** button (1) in the **Alarm Limit Manager** toolbar is a shortcut to the measuring point register where alarm limits may be edited if required. Double clicking on a row in the list of measuring points also takes you to the measuring point register.
- Click any column head to sort the list by that column.
- To scroll the list, use your keyboard arrow buttons, or the scroll bar.

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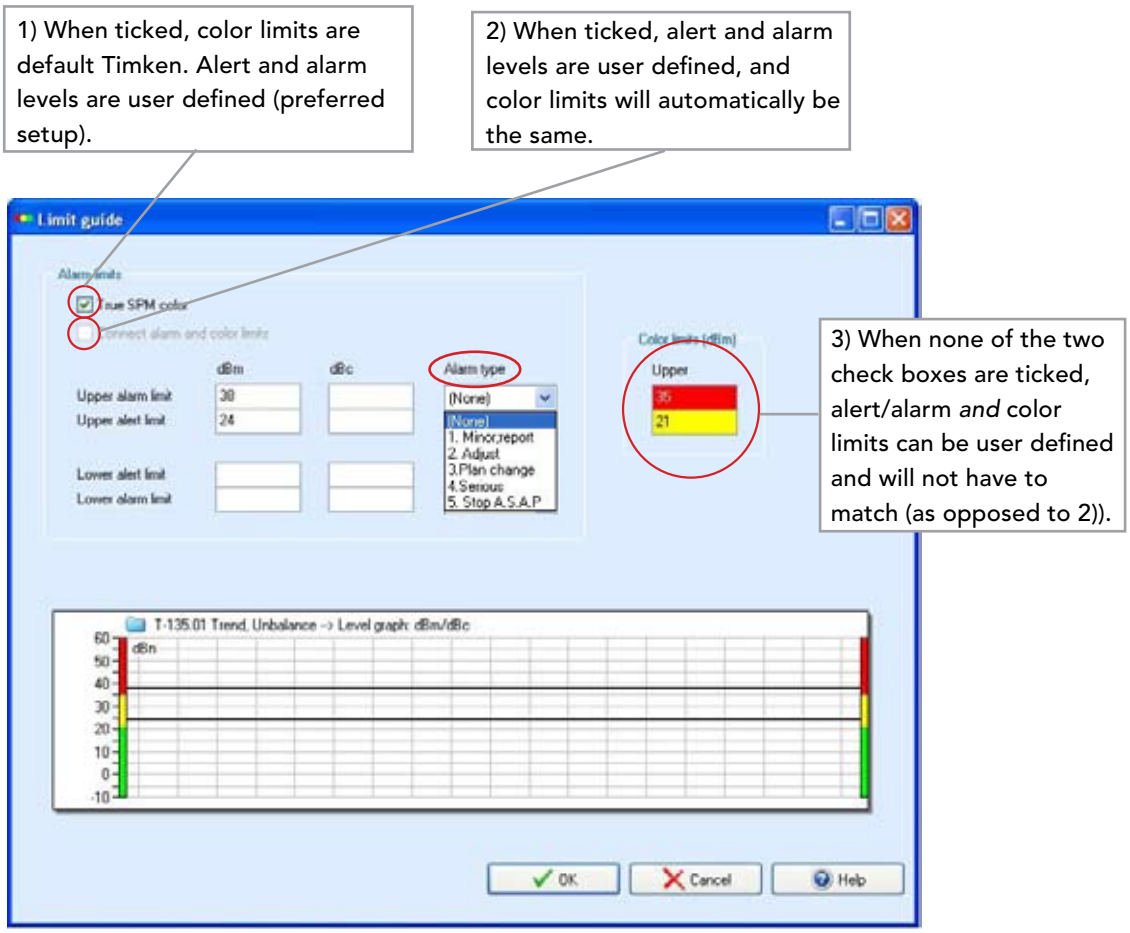

Flexible alarm limits

Via the **Alarm limits** function in the measuring point register, it is now possible to set alert as well as alarm levels for all parameters. For example, you may set individual alert (yellow) and alarm (red) levels for dBm, dBC, LR and HR, respectively.

Normally, you'll want to retain the default Timken color limits while entering your own alarm limits (see 1) in the figure below). However, you may also enter alternative color limits (3), or have them be the same as your alarm limits (2). For instance, for a machine that you know is in good condition even though readings are "in the yellow", indicating a possible problem, customizing your alarm and color levels is a convenient way to avoid unnecessary alerts and/or alarms.

Only one of the two check boxes under **Alarm limits** may be ticked at any given time.

When color and alarm limits are connected (2), dBm (or LR) is the controlling value of the scale. NOTE: this does not apply when measuring LR/HR on a variable speed application, when green - yellow - red cannot be obtained. Alarm limits are then rpm dependent.

When none of the two check boxes is ticked, you can edit the **Color limits** (3).

Any limits you input are immediately reflected in the graph.

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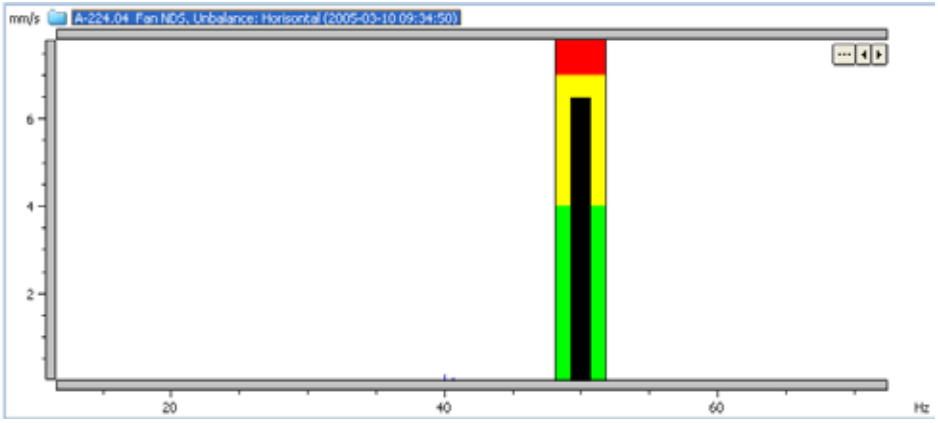


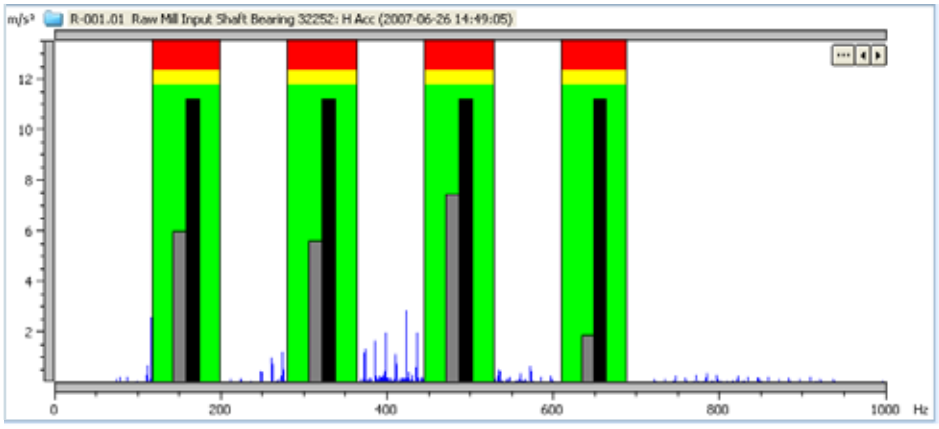
Bands

In spectrum analysis, it can be difficult to distinguish the spectrum lines of a particular symptom from those of another; the energy content will sometimes "spill over" into neighboring frequencies. Bands are an efficient way to "isolate" the symptom frequencies from each other. To accomplish this, the RMS value of all the amplitudes within a user defined frequency range are added. The result is a bar graph of the energy contained in the different frequency bands. Bands can be used when you want to study a broader frequency range, e.g. covering an entire production cycle.

Careful tuning of the frequency range for individual bands (**Band settings**) will "separate" the symptoms, resulting in improved alarm reliability. Random high readings caused by resonance or sources of disturbance are filtered out, minimizing the number of false alarms. Finding the optimum band settings is largely a trial-and-error process, and may also vary depending on the selected spectral window type (Hanning etc.).

For variable RPM applications, there is no need to measure rpm if the variation is known and you set the **Band settings** parameter to cover that range. Ticking the **By orders** checkbox makes the band entirely rpm dependent; it will "slide along" with rpm as it changes within its upper and lower variation limits.

Bands produce bar graphs, as opposed to spectrum analysis which shows single frequency lines.



Multiple bands

The **Multiple bands** function illustrates multiples of rpm; the more serious the problem, the more multiples are shown. Multiple bands will further clarify the symptoms and can be used for trending purposes. Grey bars represent the RMS value of that particular band, while black bars represent the combined RMS values of all bands in the spectrum.

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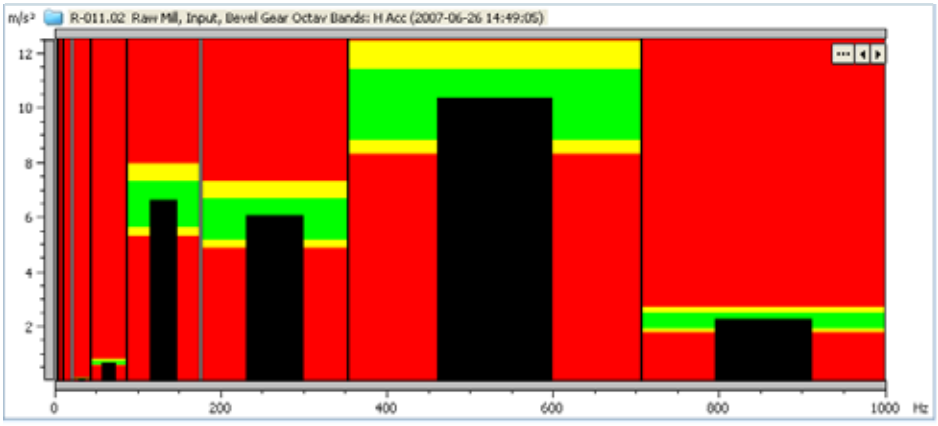

Octave bands

Spectrum analysis with FFT is appropriate for resolving higher-frequency harmonics and sidebands. However, sometimes FFT analysis provides more detail than you need; the detection of certain machine faults does not require such high resolution. When this is the case, octave analysis may be a better option. Typically, octave analysis is used for gearboxes and high rpm applications.

In octave band analysis, frequencies are segmented into proportionate widths (octave bands). An octave band is the interval between any two frequencies having a ratio of 2 to 1. This means each band occupies a bandwidth that is twice as wide as the previous band and half as wide as the next. In spectral analysis, all frequency bands occupy equal bandwidth.

Constant percentage bandwidth

The type of octave band used in Condmaster is called *constant percentage band*. A constant percentage bandwidth filter is a bandpass filter where the width of each frequency band is a constant percentage of its center frequency. Each octave band has a bandwidth equal to about 70% of its center frequency. This means the bands become wider in proportion to their center frequencies:

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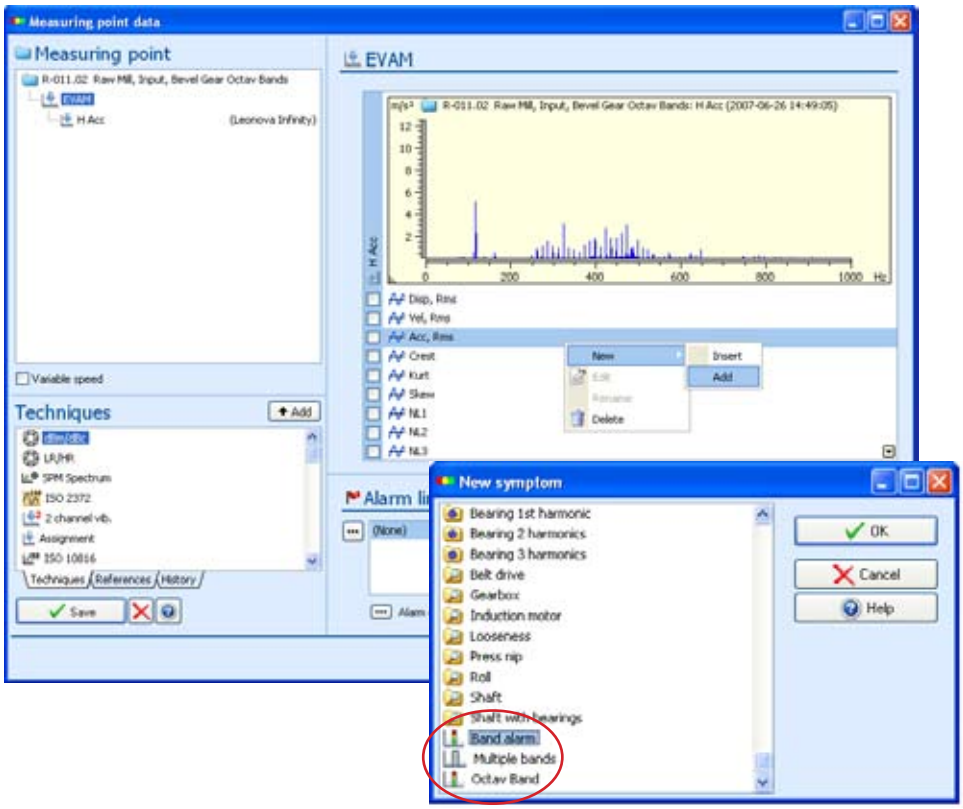

Implementing bands

The various forms of bands are implemented from the **Measuring point data** form.

Mark a measuring assignment, then right click in the symptom overview and select **New** > **Add** or **Insert**. From the list of symptoms, select a band alarm type (**Band alarm**, **Multiple Bands** or **Octave band**):

Band alarm

In the **Band alarm** window, input **Band settings** wide enough to cover the peaks of the spectrum.

For alarm limits, you may input your own levels or have Condmaster calculate them for you. By default, the **CALCULATE** button (available for Bands and Multiple bands) will look at the latest reading and add 20% to calculate where on the conditon scale yellow condition will apply. For red condition, 40% is added to the latest reading. You can change these percentages, and if you do, they will remain in the system as the new defaults. Alarm limits are mm/second.

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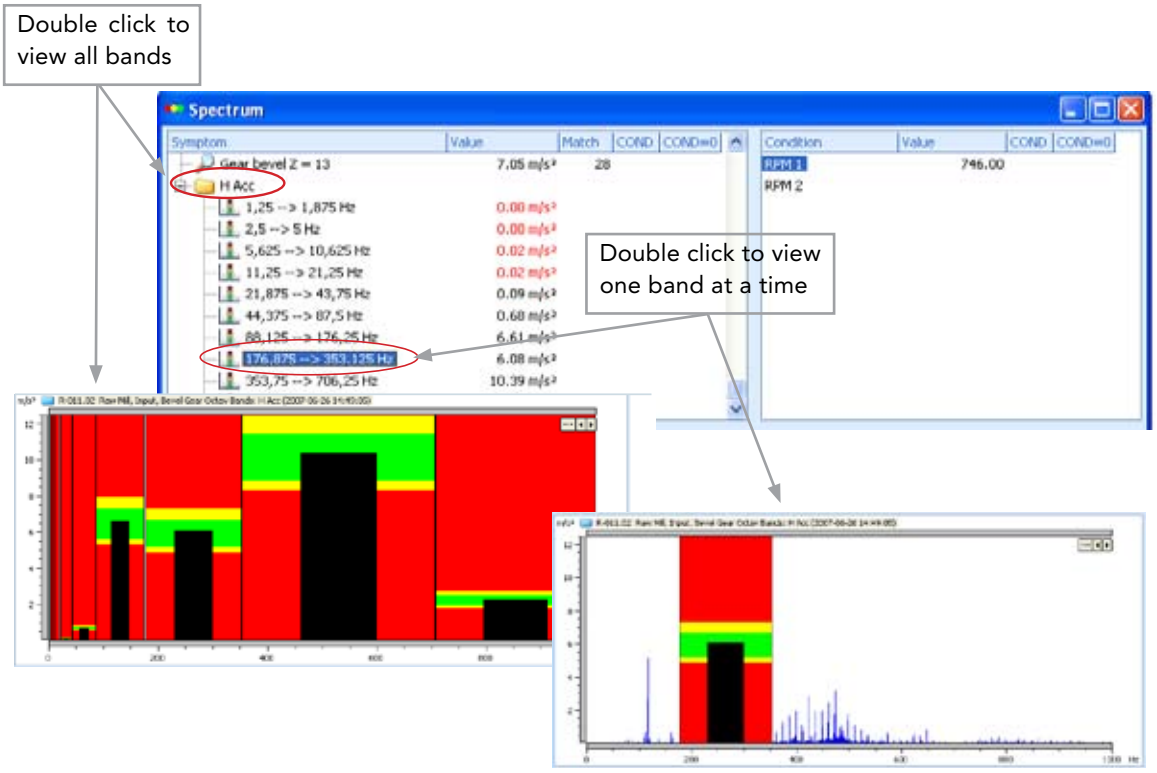


When looking at a spectrum, double click on the measuring assignment in the **Spectrum** window to display the bands. To view only one band at a time, double click on a frequency range.

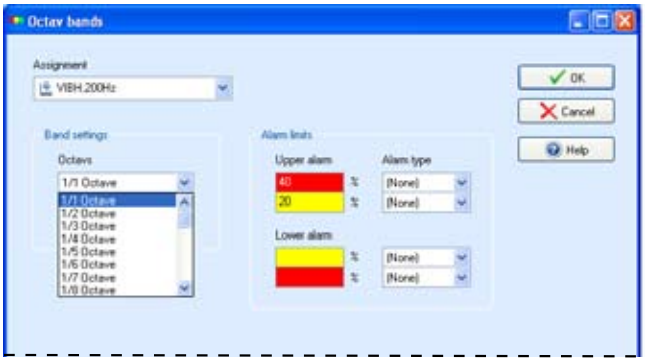
Multiple bands

In the **Multiple Bands** window, click **NEW** to input multiple **Band settings** wide enough to cover the peaks of the spectrum.

Use the **CALCULATE** button for alarm limits, or input your own.

Octave bands

Depending on what resolution you want in the spectrum, select an appropriate fraction of an octave in the **Octave bands** window. In many cases, one-third octave bands are sufficiently narrow.



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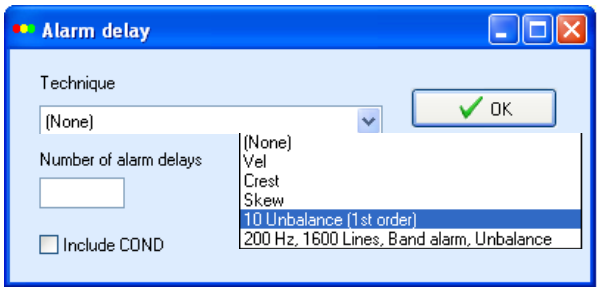

Alarm delay

Alarm delay is useful to obtain stable and well justified alarms. This function delays the alarm by a user specified number of readings and determines when alarms will be raised. All readings from the measuring unit are still saved to the Condmaster database; the "filtering" is done in the graphical display only.

The function is accessed via the **Alarm Delay "..."** button under **Alarm limits** in the **Measuring point data** form. The **Number of alarm delays** setting means *this number of **consecutive** readings* must be on or above the alarm limit before an alarm is actually raised. When applicable, tick the **Include COND** checkbox. This means alarms will be raised on raw values as well as condition parameters.
When an alarm delay is set, readings exceeding the alarm limit are counted and evaluated against the filter setting. If for instance the delay filter is set to 4, above-alarm-limit readings are not displayed and no alarm will be generated *until four consecutive readings* exceed the alarm limit. Reading no. 4 will then be be displayed in the **Graphical Evaluation** and will also cause an alarm.

Example
Alarm delay: 4
Alarm limit: 36

Date	*Reading*	*Displayed in graph?*	*Alarm?*
2009-10-06	34	Yes	- -
2009-10-05	40	Yes	No
2009-10-04	***36***	***Yes***	***Yes***
2009-10-03	39	No	No
2009-10-02	38	No	No
2009-10-01	37	No	No
2009-09-30	33	Yes	- -
2009-09-29	29	Yes	- -
2009-09-28	32	Yes	- -

To confirm that readings are indeed "consistently" and not randomly high, a series of high readings is thus required. In the example above, four consecutive readings above the alarm limit is considered reliable enough to merit an alarm. You may need to experiment a bit with the delay setting to find out what number is required to exclude any false alarms for a certain measuring point.

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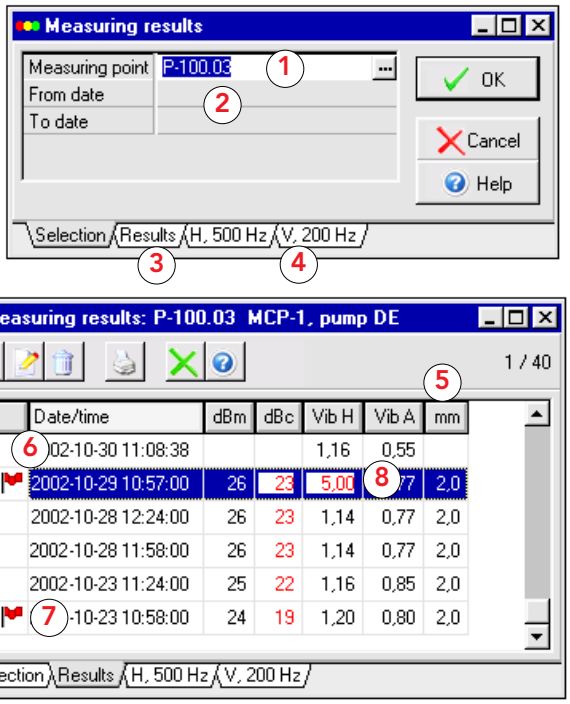

Measuring results:

- Select measuring point (1) and time span (2)
- Select technique (3, 4)
- Use the keys INSERT, ENTER, and DELETE for manual input, editing, and deleting of **Results** (not EVAM)

Measuring result register

All measuring results are stored in the measuring result register. This register can be selected under **Maintenance** in the menu bar. The measuring point is selected via the tree structure after clicking on the "**...**" button (1). You can limit the list of measuring results by setting a **From** date, a **To** date, or both (2). When you jump from e. g. **Graphics**, you go directly to the marked measuring point or technique.

Depending on the active measuring techniques, the form shows tabs for **Results** (3) and/ or EVAM assignments (4). Click on a tab to open the result list. **Results** contains all active measuring techniques except EVAM parameters, which are listed under the assignments. The header for alternative measurements (5) is the measuring unit set under the measuring point data.

When you access it, the measuring result list is sorted by date, with the latest result at the top. You can change the sorting by clicking on any of the headers. This will put the highest measuring result for this measuring technique at the top of the list and sort the list by value, with secondary sorting by date. The colored dot (6) shows the status at the time of measurement. A red flag (7) shows that the point is on the alarm list. A red value (8) means that an alarm limit has been exceeded.

Values on the **Results** form can be manually input (press INSERT on the keyboard) and edited (mark and press ENTER). All values can be deleted (mark and press DELETE). EVAM results cannot be edited and are input exclusively via data logger or online measuring unit. You can, however, input a new VIB reading from the assignment form.

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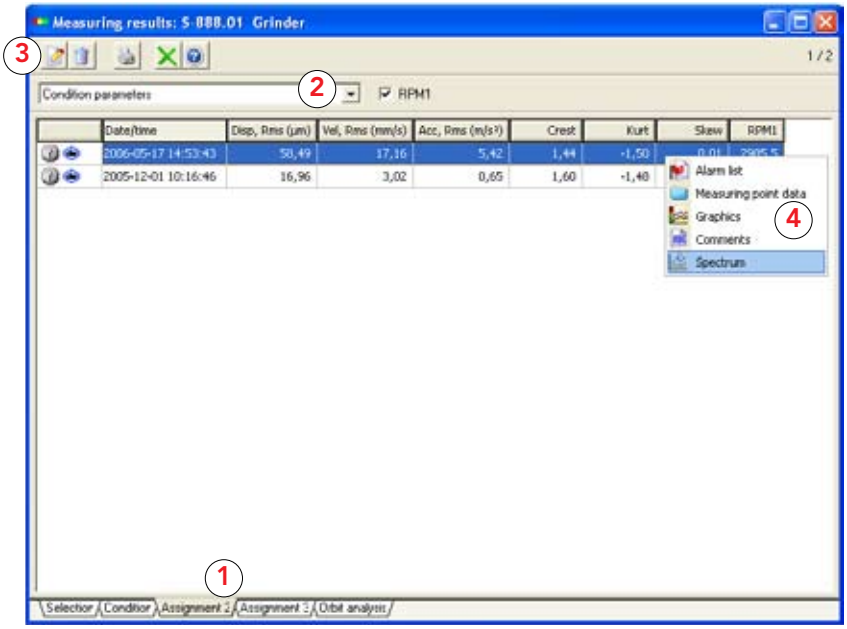

EVAM:

- Select parameter display (2)

Measuring results for EVAM

To see the measuring results for EVAM, click on the assignment tab(s) (1). The results are displayed in groups: condition parameter values, symptom parameter values, and speed. Use the drop down button (2) to change the display.

EVAM measuring results cannot be manually input. However, they can be deleted. Pressing DELETE on the keyboard removes the marked results.

The only editable value for EVAM measuring results is rpm. Mark a result row in the list and click the **Edit measuring result** button (3, upper left corner). Input a new rpm value and click **OK** to return to the **Measuring results** window.

From the measuring result window, there are jumps to other functions. Right hand click in the list to obtain the menu (4).

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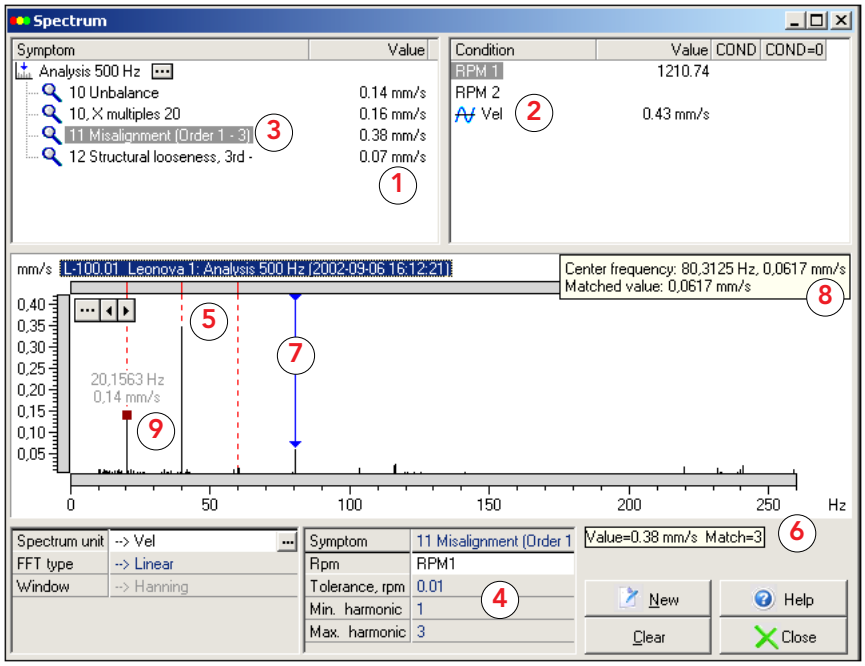

Symptoms:

- Compare symptom parameter values (1) and VEL (2)
- Double click on symptom (3) to mark matching line(s)

Spectrum and symptoms

The function **Spectrum** shows a single spectrum based on one measuring result. Measuring point number, name, assignment, date, and time are displayed above the spectrum field.

The field at the top left shows the symptoms attached to the assignment. The symptom parameter values (true RMS value of all matching lines in mm/s) are listed under the header **Value** (1). You can compare these values with the value for the condition parameter VEL (2) to see how much of the total vibration energy is due to any single symptom. The columns **COND** and **COND = 0** remain empty until you have made an evaluation criterion for the assignment.

Double clicking on a symptom marks it (3) and puts the named symptom parameters into the field below the spectrum (4). Matching spectrum lines in the spectrum are marked with red broken lines (5), within the tolerances set for the symptom. The symptom parameter value and the number of matching lines are repeated above the **NEW** button (6).

Tapping and holding anywhere in the spectrum field produces a vertical blue marker (7) ending on top of a spectrum line. Line position and amplitude are displayed in a yellow popup box (8). The blue arrow can be dragged all over the spectrum. For fine work, move it with the RIGHT/LEFT arrow keys.

Tapping on a spectrum line marks it with a red square (9) and displays its position and amplitude.

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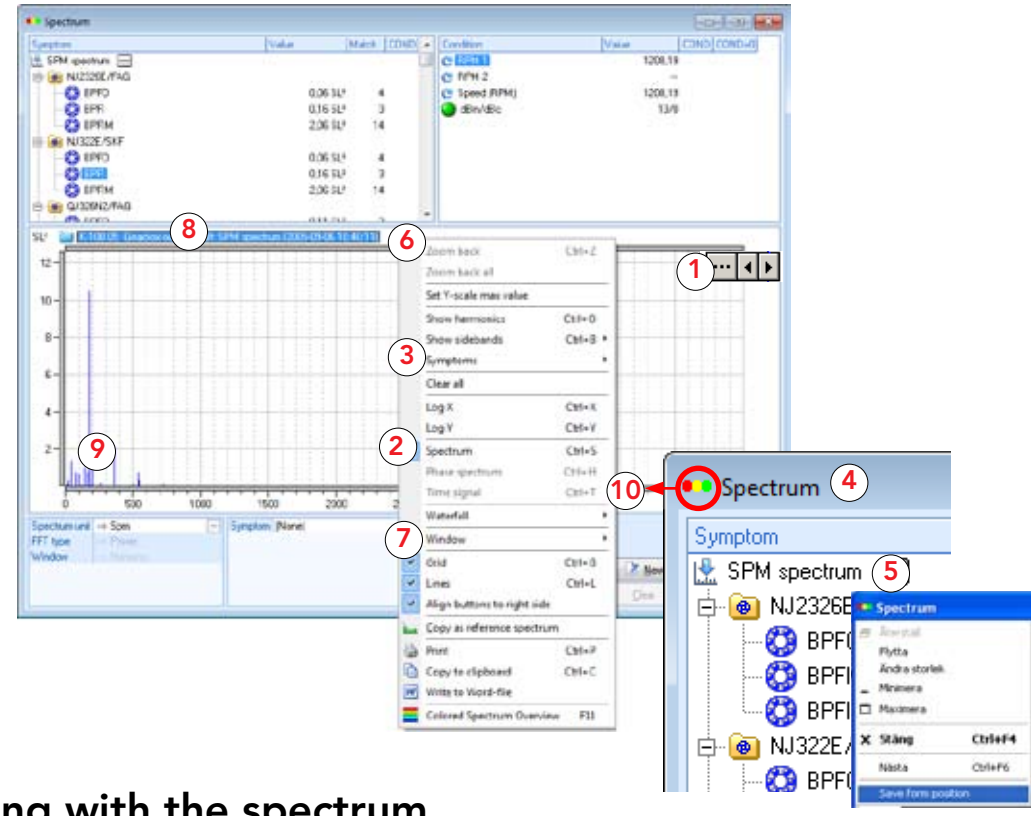

Working with the spectrum

Clicking on "**...**" (1) or right hand clicking in the spectrum field opens a menu (2) which allows you to manipulate and print the spectrum. The arrow buttons beside it lead to the spectrum measured before or after the one shown, if any.

Symptoms (3) on the menu leads to further choices (4). Marking **Symptom bar** produces a gray bar (5) above the spectrum. The menu (4) is then available when right hand clicking on this bar. **Theoretical lines** marks the exact position of the active symptom with broken blue lines. **Show all** and **Hide all** turns the markers inside the symptom field on and off.

The zoom window (6) appears when you zoom in on part of the spectrum by dragging the cursor over it. The zoom window can be enlarged/reduced and dragged into any part of the spectrum field. To lock the zoom window in its present position, click the red-yellow-green dots in the upper left corner of the **Spectrum** window title bar (10) and select **Save form position** from the popup menu. The zoom window will then retain its position when zooming next time.

The zoom window shows the zoomed area in grey. The grey part can be moved inside the zoom window, enlarged and reduced. This changes the zoomed part of the spectrum accordingly. Right hand click on the zoom window to turn it off. It can be recalled with **Window** (7). **Window** also toggles between **Spectrum** and **Time record** (if available).

When the blue marker is on a line belonging to any of the selected symptoms, the symptom name is shown in the yellow window (8).

Grid (9) turns the grid in the spectrum on/off. **Lines** (9) connects the vertical staples representing the spectrum lines with a continuous line, and turns this function off again. Please note that the representation of a spectrum by a continuous line moving up and down is a purely optical measure. The FFT process produces individual values at individual points along the frequency axis, so showing these as staples is the realistic method.

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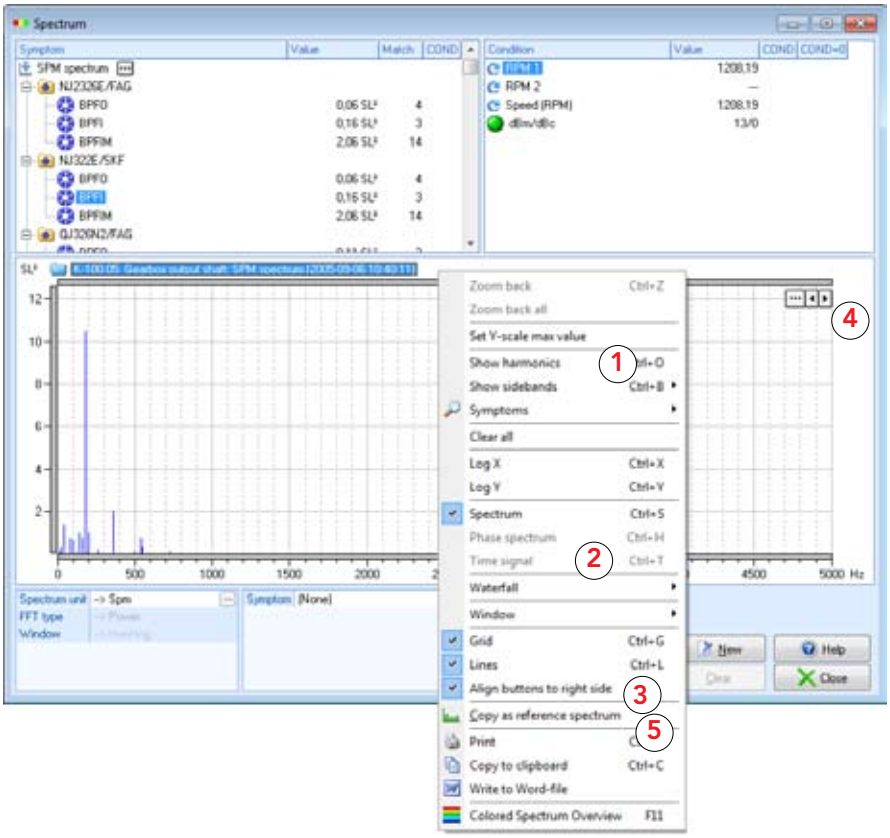

Working with the spectrum

Described here are the popup menu options that are new in Condmaster Nova.

Set Y-scale max. value (1) lets you adjust the spectrum Y-scale as required.

Three spectrum types are now available via the popup menu:

- **Spectrum** (2)
- **Phase spectrum** (2)
- **Time signal** (2)

Align buttons to right side (3) moves the "..." and arrow buttons (4) to the right side of the spectrum window and locks them in this position.

Any spectrum stored in the database can be set as a reference spectrum for any assignment. To set the selected spectrum as reference on a measuring assignment, open the spectrum that should be used as reference and select **Copy as reference spectrum** (5). See **Reference spectrum** later in this manual.

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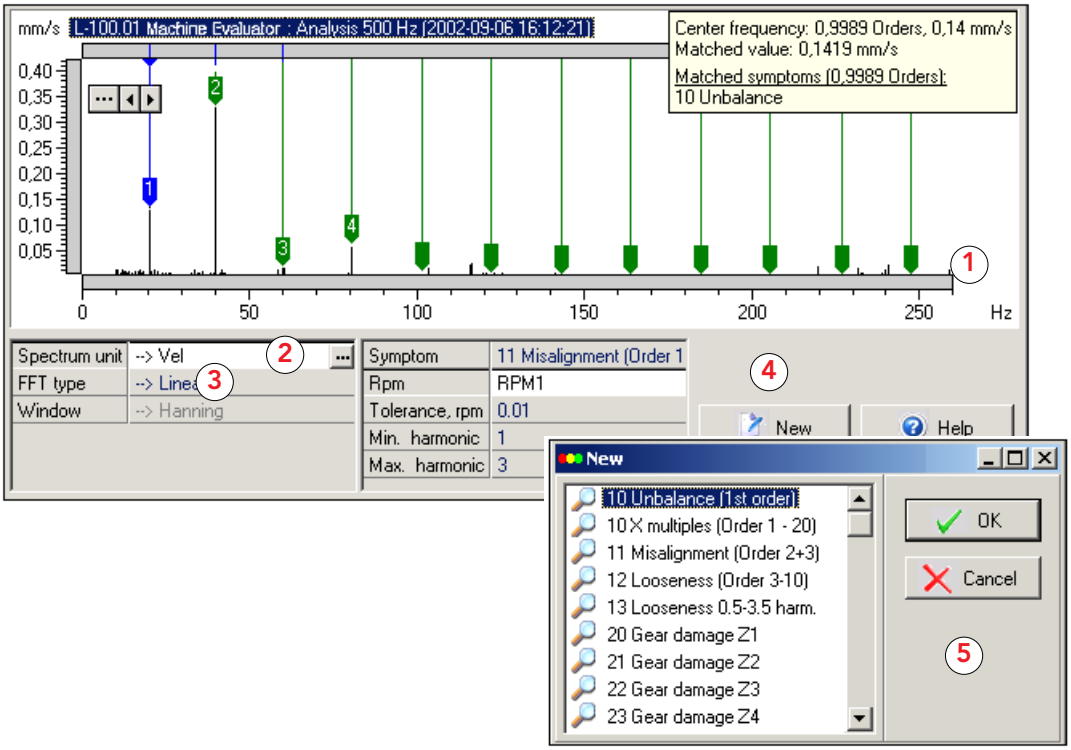

Working with the spectrum

Clicking in the frequency unit (1) toggles this unit from Hz to CPM to Orders (order 1 = 1X, the frequency corresponding to the rpm of the shaft).

Show harmonics marks all multiples of the blue arrow position with green lines. **Show side bands** produces a menu were you select the number of side bands to be shown. The centre position is the position of the blue arrow. Side bands are marked at 1X distance on either side of the blue arrow. This function is used to check on rpm modulation of a frequency, common in connection with inner race damage and gear damage.

The spectrum unit is normally VEL (velocity in mm/s). It can be changed (2) to ACC (acceleration) or DISP (displacement). The spectrum type (3) can be changed from **Linear** to **Power** or **Power density**. The window can be changed in case a time record is available.

The button **NEW** (4) is used to call up any standard symptom from the register (5), in case you try to find matching symptoms which are not attached to the assignment. You can edit the symptom parameters without affecting the originals.

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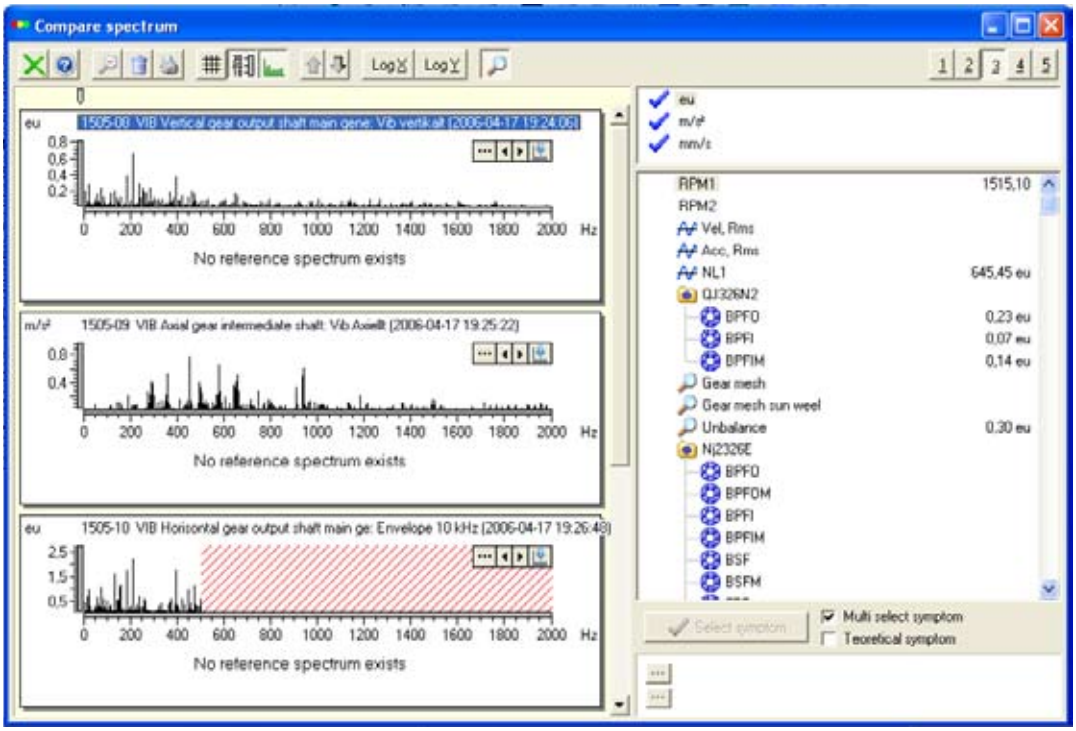

Compare spectrum

The **Compare spectrum** function has been enhanced in Condmaster Nova in order to accomodate requirements to view more than one frequency range and/or resolution at a time. This means that you can now implement a variable frequency range from one measuring assignment to another and also between measuring points.

Further improvements in the **Compare spectrum** function are:

- the possibility to display a list of symptoms, where one or several symptoms can be highlighted for easy evaluation. Each symptom can be assigned an individual color and its name displayed in the spectrum.
- The Y scale can be manually set or optimized per individual spectrum.
- Reference spectrums can be set and be displayed or hidden as required.
- The possibility to change the display order of spectrums or delete any spectrums in between, enables comparison between spectrums from the same measuring point at different points of time.
- When calling the single spectrum function, zoom and symptom settings are retained.

When you plan to start working with Compare spectrum, it is advisable that you begin by deciding what symptoms should be shown in the spectra, and in what colors. These settings will apply to all spectrums throughout Condmaster. Select all measuring points by marking the **Measuring points** folder in the Graphical Overview, then click the **Spectrum** button in the tool bar. In the right part of the **Compare spectrum** window, select each symptom that you want shown in the spectra, then click the "**...**" button to make settings for color and whether or not symptom names should be shown in the spectra.

For more information about the **Compare spectrum** window, please turn to section "Working with Compare Spectrum" in this chapter.

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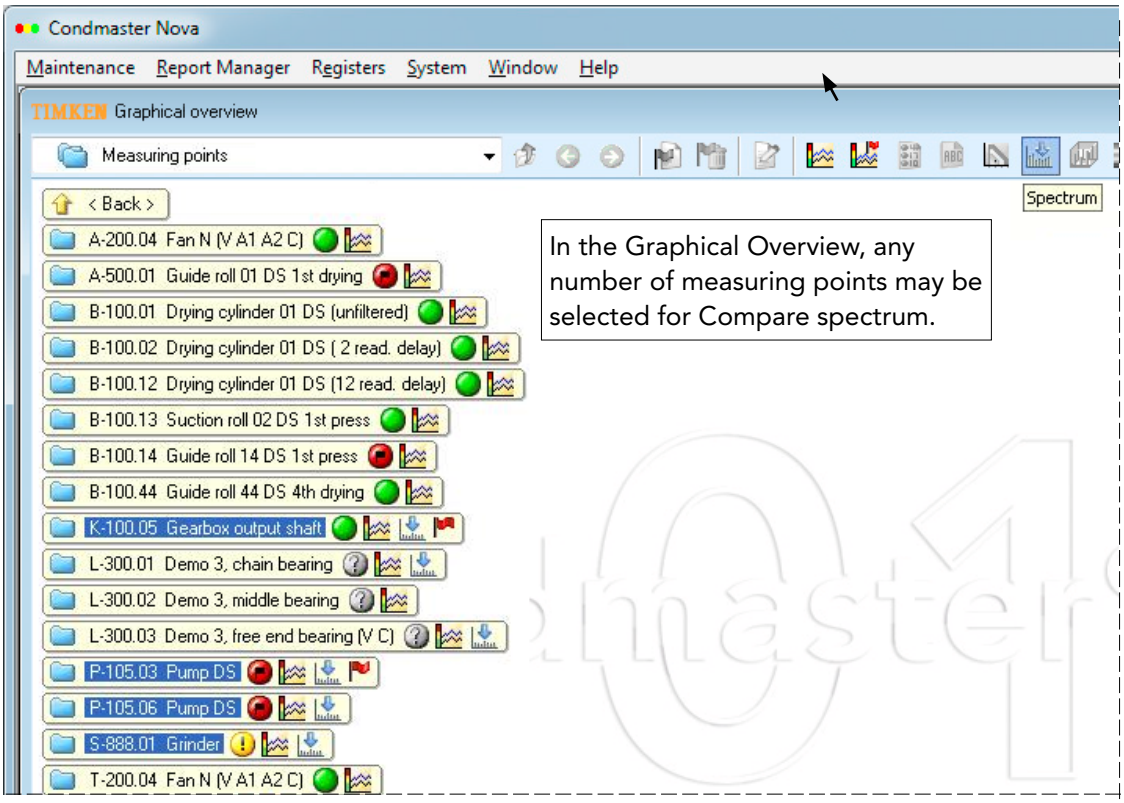
Condmaster Nova
Maintenance
Report Manager
Registers
System
Window
Help
TIMKEN Graphical overview
Measuring points
Spectrum
< Back >
A-200.04 Fan N (V A1 A2 C)
A-500.01 Guide roll 01 DS 1st drying
B-100.01 Drying cylinder 01 DS (unfiltered)
B-100.02 Drying cylinder 01 DS (2 read. delay)
B-100.12 Drying cylinder 01 DS (12 read. delay)
B-100.13 Suction roll 02 DS 1st press
B-100.14 Guide roll 14 DS 1st press
B-100.44 Guide roll 44 DS 4th drying
K-100.05 Gearbox output shaft
L-300.01 Demo 3, chain bearing
L-300.02 Demo 3, middle bearing
L-300.03 Demo 3, free end bearing (V C)
P-105.03 Pump DS
P-105.06 Pump DS
S-888.01 Grinder
T-200.04 Fan N (V A1 A2 C)
In the Graphical Overview, any number of measuring points may be selected for Compare spectrum.

Selecting measuring points for Compare Spectrum

To view the **Compare spectrum** function, first select the measuring points (or folders) in the Graphical Overview. Hold down the Ctrl button on your keyboard and left click on each measuring point of interest, then click on the **Spectrum** button in the tool bar. Measuring points can also be selected by dragging across them with the left mouse button held down.

If a selected measuring point has more than one assignment, all of them will be included in Compare spectrum.

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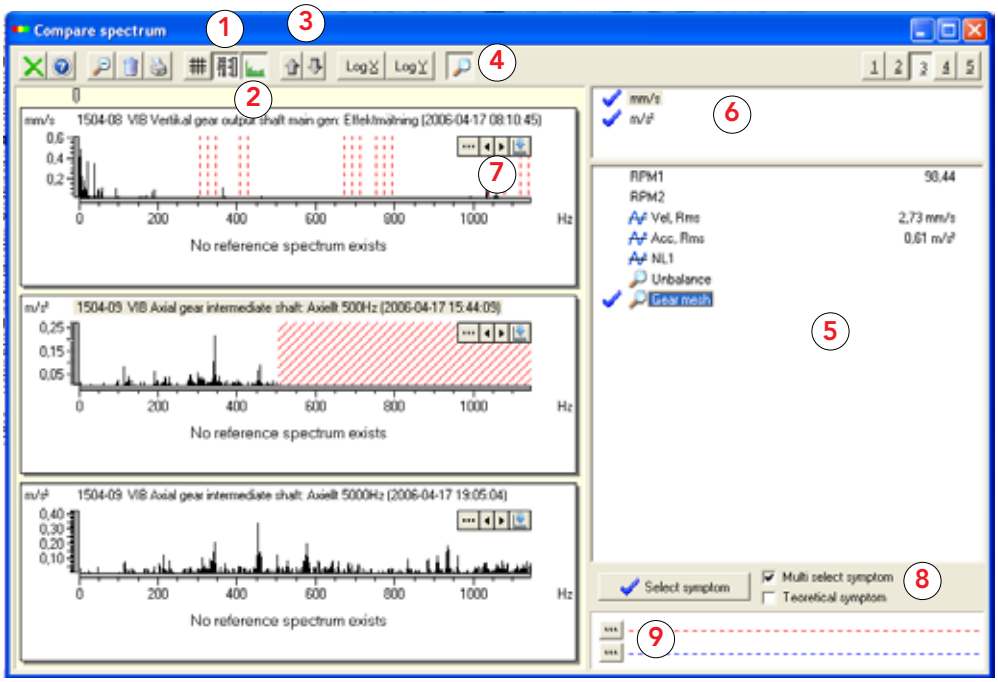

Compare spectrum window

Working with Compare spectrum

In the **Compare spectrum** window, the **Individual Y-scaling** button (1) turns optimization of the individual spectrum scaling on or off.

Click the **Show reference spectrum** button (2) to show/hide any reference spectra available.

Mark an individual spectrum and use the arrow buttons (3) to move it up or down in the list of spectra.

The **Show symptom list** button (4) displays or hides the symptom list to the right (5). Select symptoms to show in the spectra from this list by double clicking on the symptom(s), or by marking them and clicking on the **Select symptom** button. The lines then shown (standard color = red) are the actual matches for the symptom in question. To instead see where the peaks should theoretically appear e.g. for a damaged inner ring, tick the box **Theoretical symptoms** (8) (standard color= blue).

Marking the box **Multi select symptom** (8) makes it possible to select numerous symptoms.

Use the "**...**" buttons (9) to change the symptom line standard colors and to display or hide symptom names in the spectra.

Double clicking on a spectrum unit (6) displays or hides all spectra with this unit.

In the individual spectrum, you can move between measurements by clicking on the left/right arrows (7). A right click in the spectrum brings up a popup menu where e.g. the spectrum can be set as reference spectrum. Right clicking while moving the mouse brings up a movable cursor. Zooming in the frequency ranges is possible using the left mouse button and dragging in the spectrum. Use the **Zoom back** button in the tool bar to zoom back.

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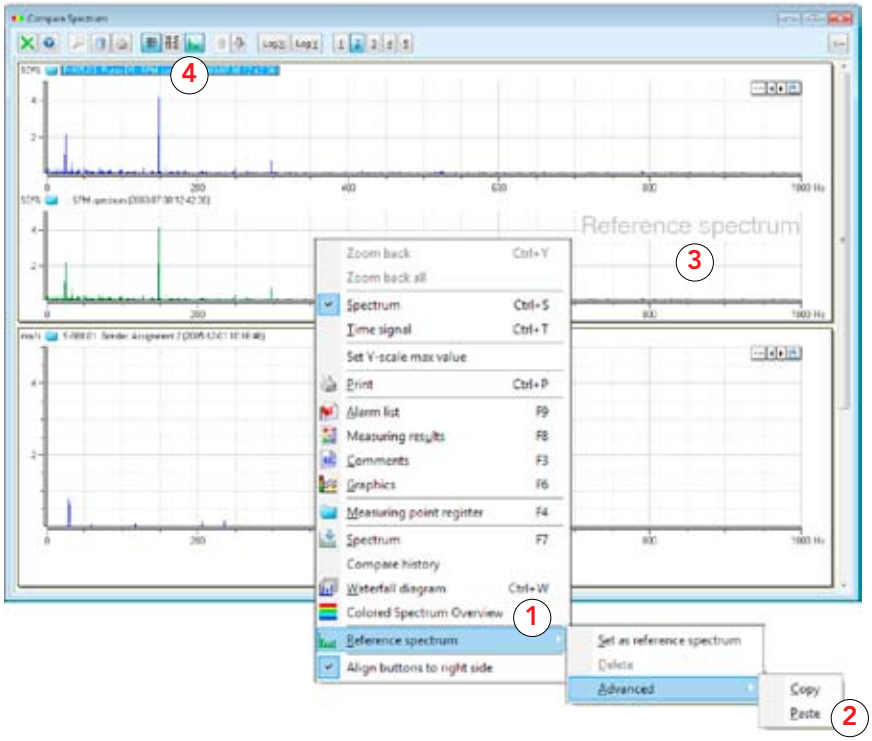

Set a spectrum as reference:

- Right click in the spectrum
- Select **Reference spectrum/Set as reference** (1)

Reference spectrum

Any spectrum stored in the database can be set as a reference spectrum for any assignment. However, an assignment can only have one reference spectrum at any given time.

To set a reference spectrum for an assignment, right click on the spectrum and select **Reference spectrum** on the drop down menu. Select **Copy as reference spectrum** to define the spectrum as reference for *the current* measuring assignment.

Then bring up the assignment spectrum which is to refer to the copy. If there is only one spectrum, mark at least two assignments with spectrum. Press the spectrum icon on the top menu and the **Compare Spectrum** window will open. Press the "..." button or right hand click to open the drop down menu (1) and select **Reference spectrum/Advanced/Paste** (2). The reference spectrum will be placed under the assignment spectrum and is marked "Reference spectrum" (3). Use the button (4) to close or show the reference spectrum.

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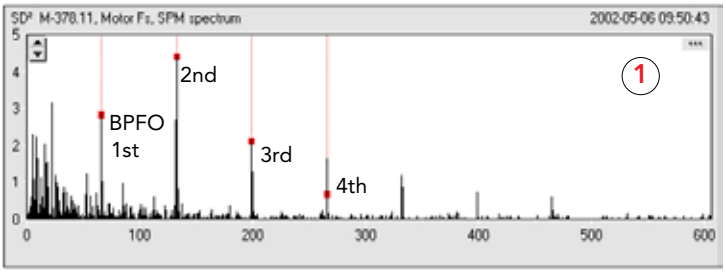
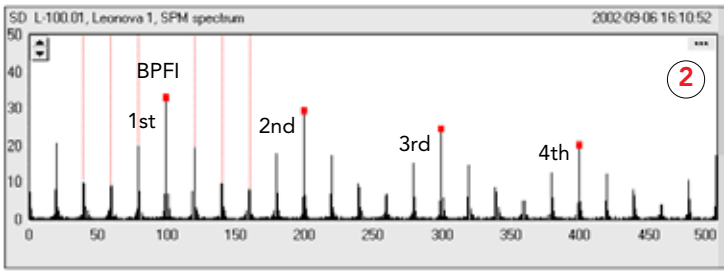
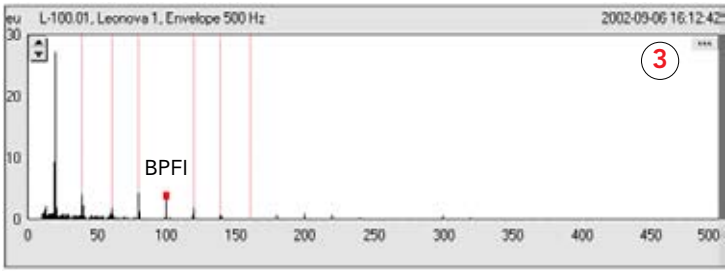


Outer race pattern:
Non-rotating. Symptom BPFO. No side bands but strong multiples indicating heavy damage.

Inner race pattern:
Rotating. Symptoms BPFI (centre frequency) and BPFIM (side bands), SPM Spectrum.



Same pattern from same measuring point in an enveloped vibration spectrum



Pattern recognition in an SPM Spectrum

Figures 1 and 2 show very clear patterns from damaged bearings. In both cases, the shock values are in the red condition zone.

Typical for a non-rotating, damaged outer race (1) is a strong line at BPFO (ball pass frequency, outer race). There are no side bands because the race is stationary relative the bearing's load zone. Usually, this line has a number of multiples. Marking the line in the spectrum produces the red dot and writes its position and amplitude above the line. With **Show harmonics** you produce a grid of red lines marking all multiples.

Typical for a rotating, damaged inner race (2) is a strong line at BPFI (ball pass frequency, inner race) with a group of side bands. The spacing between these lines is 1X (the rotational speed of the shaft in Hz). The side bands indicate that the signal amplitude at BPFI is increasing and decreasing over time, due to the damaged spot moving in and out of the load zone at every shaft revolution.

Figure 3 is the result of an enveloped vibration measurement made immediately after measuring the SPM Spectrum (2). The shock pulse spectrum yields clearer data, because it is based on the time record from a calibrated resonating body (the shock pulse transducer).

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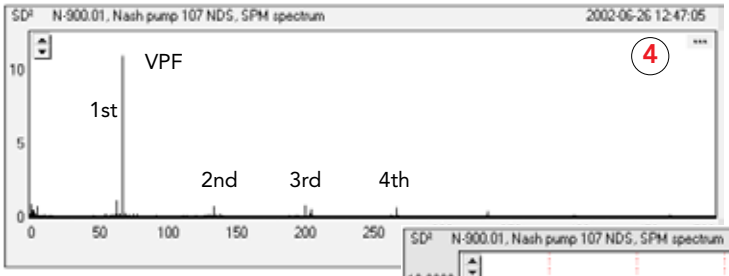
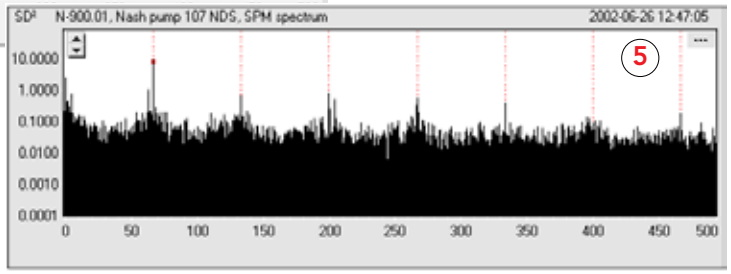
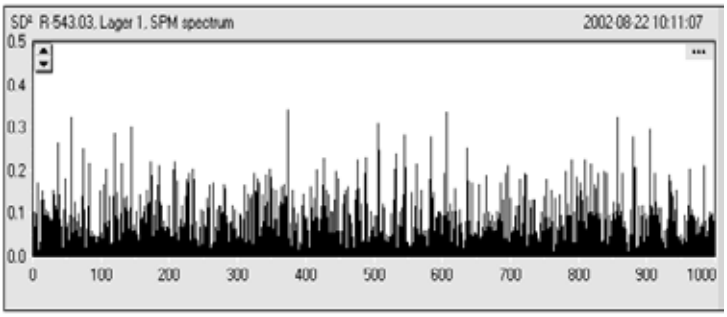


Impeller pattern:
Vane pass frequency, symptom 50. Signal measured on a cavitating pump.



Impeller pattern:
Same as (4), with a logarithmic Y-scale clearly showing the multiples of VPF.



No discernible pattern:
Matches found for all symptoms but no clear pattern. This spectrum does not allow any conclusions.

Pattern recognition in an SPM Spectrum

Negative evidence is also valuable. The SPM Spectrum in figures (4) and (5) is from a pump with a cavitation problem. The high shock values (yellow zone) are not from the bearing. The dominant frequency line matches the pass frequency of the impeller blades. The function **Logarithmic Y-scale** reveals the pattern of VPF multiples.

Inconclusive evidence is not helpful but must be expected, especially when measuring on good bearings. The SPM Spectrum in figure (6) contains no discernible pattern.

For Machine Evaluator, the **SPM Spectrum type** can be set to **Pattern recognition (SD)**, where each spectrum is scaled so that the total RMS value of all spectrum lines = 100 S_D = the RMS value of the time record. The alternative is **Symptom value (SL)**, the RMS value of the frequency component in decibel. Alarm levels are manually set for each symptom to show evaluated results in green - yellow - red.

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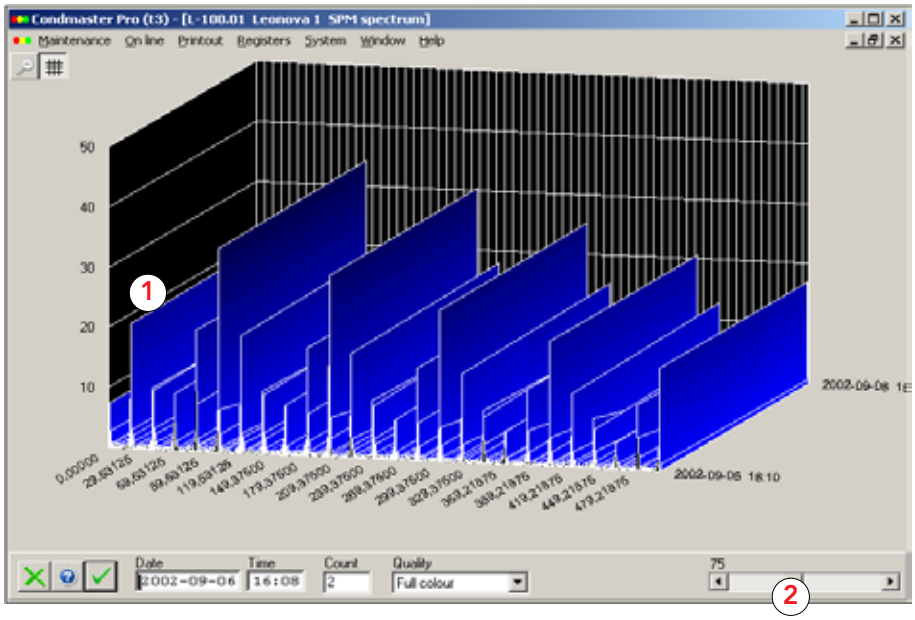

Waterfall diagram:

- Drag cursor to zoom (1)
- Select display angle (2)

Waterfall diagram

A waterfall diagram is a three dimensional display of up to 50 vibration spectra. The different readings are displayed along the Z coordinate, with the latest nearest the viewer.

You can zoom in on part of the diagram by dragging the cursor across it (1) and change the angle (2).

Order tracking

Order tracking is used with Machine Evaluator for vibration analysis on variable speed applications. It is an ideal technique for analysing vibration problems that are related to the rotational speed of various machine components. Order tracking can also be applied to SPM Spectrum measurements.

The method uses multiples of running speed (orders), rather than absolute frequency (Hz) to determine the upper frequency range. A tachometer pulse from the machine is required to determine the sampling frequency. To use order tracking, the Variable speed checkbox must be ticked (overleaf):

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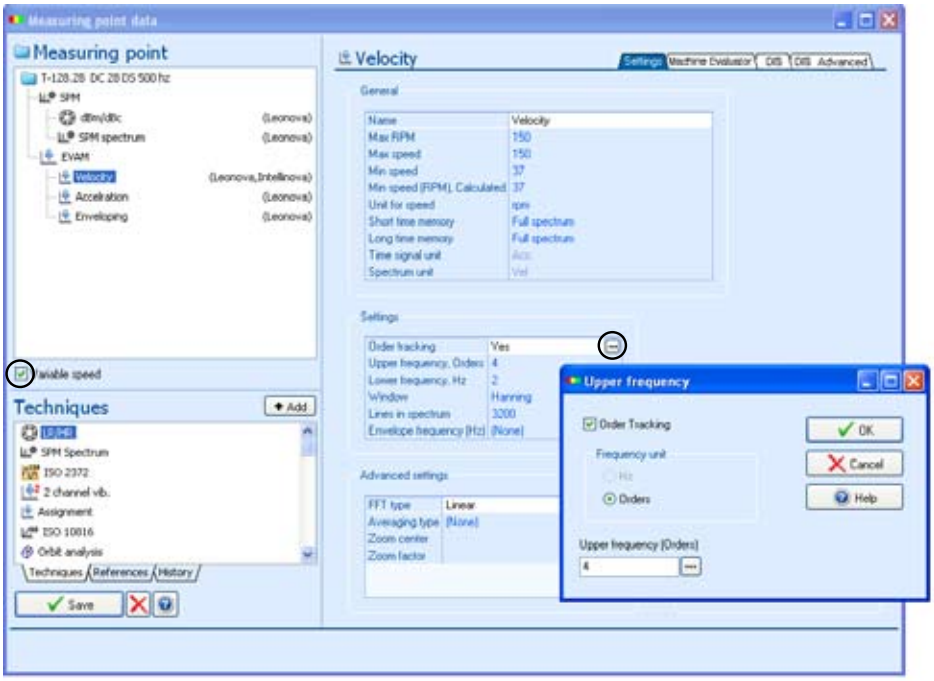
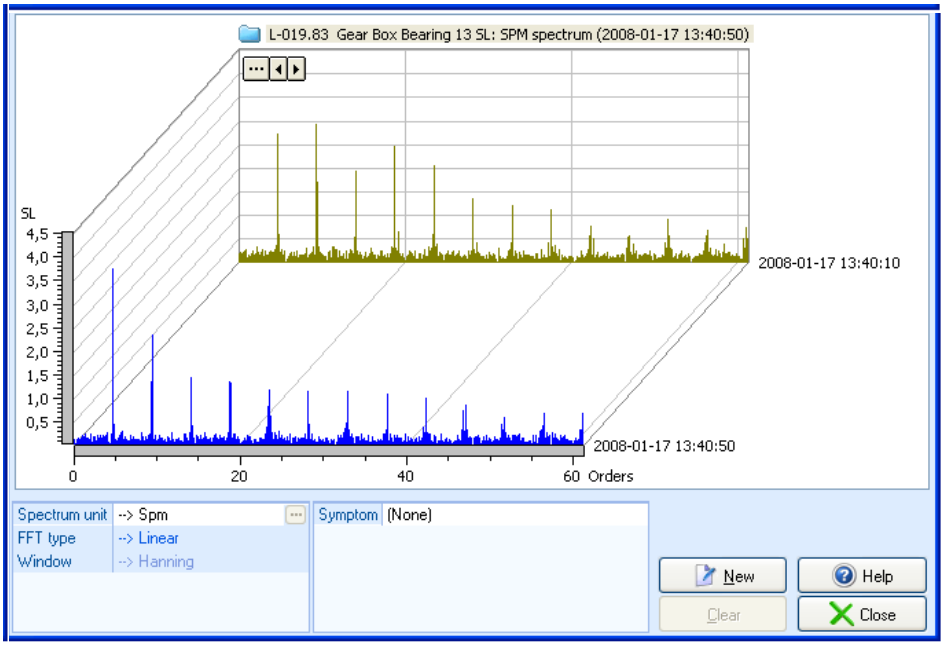
Evaluation Functions - OrderTracking



The purpose of order tracking is to retain the line resolution (number of lines per order) even when rotational speed varies between measurements. The reference axis of the resulting spectrum is scaled in orders, i.e. multiples of the rotational frequency. When expressed in orders, two or more spectra from the same machine can be more easily compared because the rotational speed (1x) and its multiples (harmonics) will always appear in the same spectrum position (orders), even when rotational speed varies. The results can also be displayed in a waterfall diagram:



The primary advantage of order tracking is that the selected order range will always cover the symptoms of interest, regardless of running speed.

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Colored Spectrum Overview

The **Colored Spectrum Overview** is a three-dimensional view of all spectrums under a particular measuring assignment. Its purpose is to simplify the process of identifying in spectrums the patterns and trends which indicate damages. In the Colored Spectrum Overview, signals which are always present in the machine are clearly distinguished from signals caused by developing damages. The Colored Spectrum Overview provides a very good overall picture of machine condition development.

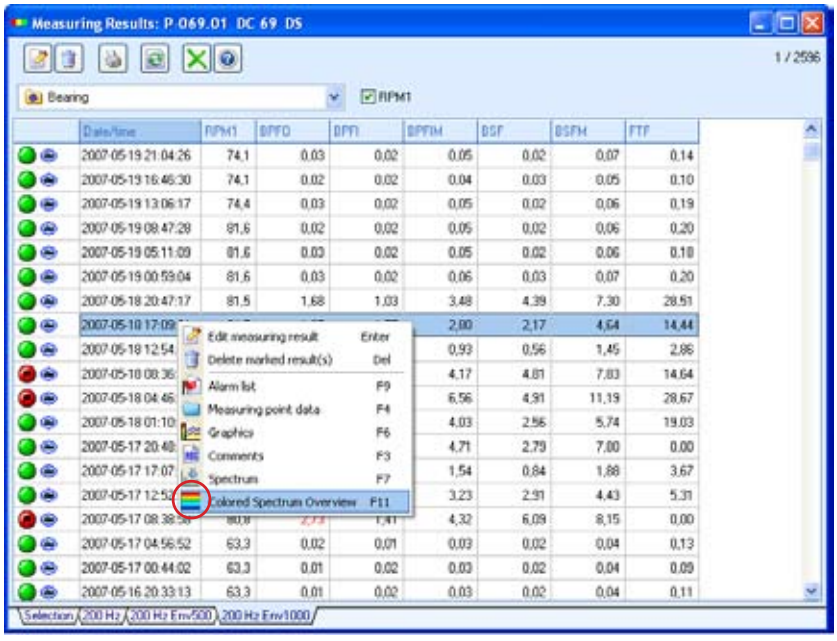
Patterns and trends are easily detected in the overview, particularly in "noisy" spectrums. There is no need to predefine what symptoms should be highlighted; the overview displays all symptoms by default. Spectrums can be viewed in orders, Hz or CPM.

Where to find it

The Colored Spectrum Overview is accessible in several ways, one of which is the **Colored Spectrum Overview** button in the Condmaster menu bar.

The rainbow-colored icon symbolizing the Colored Spectrum Overview can also be found in the following places:

- Graphical Overview
- Measuring results (see example screen shot below)
- Graphic evaluation
- Spectrum
- Compare spectrum



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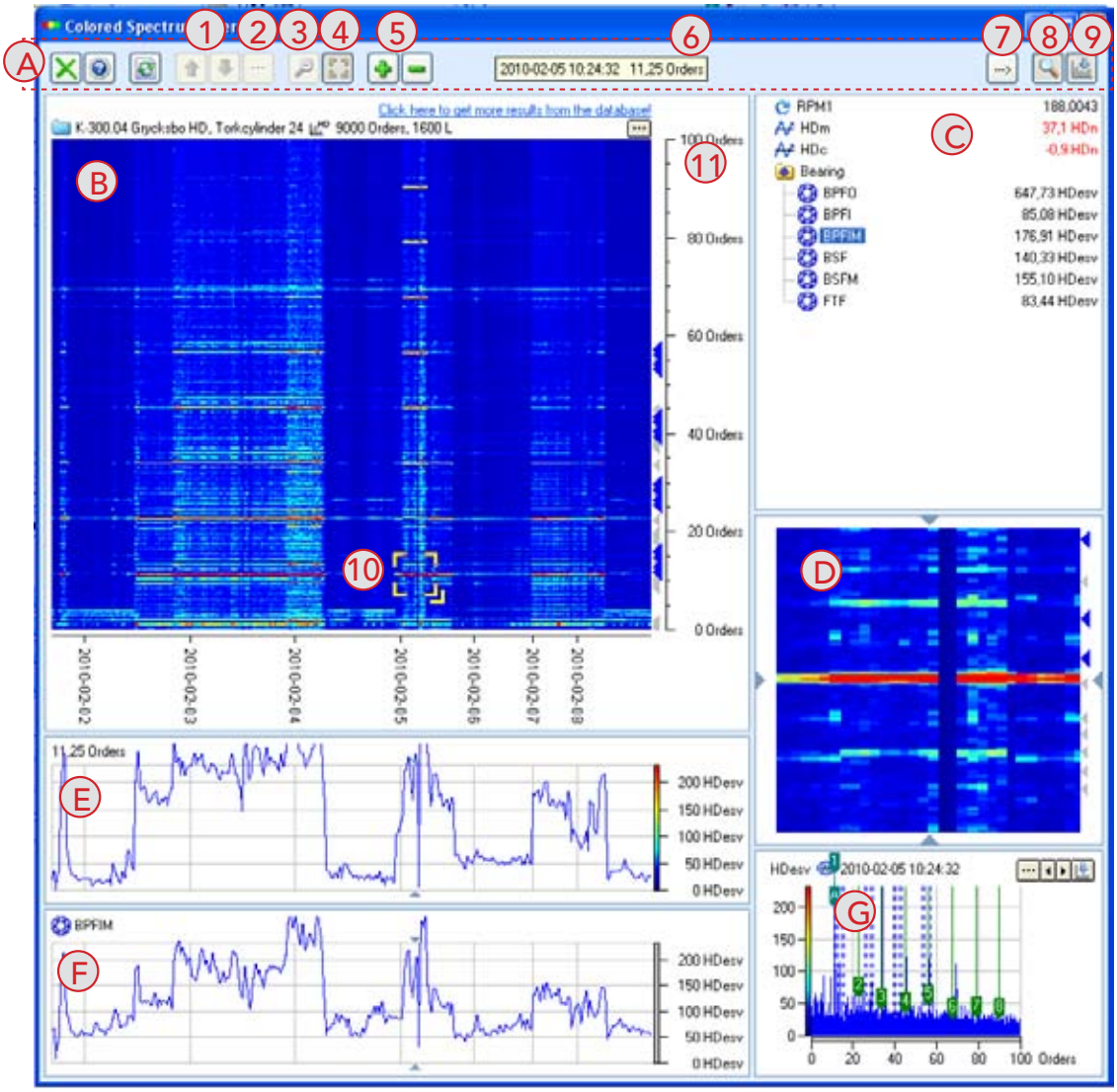

Colored Spectrum Overview functionality

The **Colored Spectrum Overview** window is packed with information. Here's a brief description of the main elements (please see screen dump on opposite page):

A) **Tool bar**: The tool bar contains the following functions:

1) Go to previous / next measuring assignment

2) Select measuring assignment from a list (applicable only when a measuring point is marked in the Measuring Point Tree, rather than an individual measuring assignment).

3) Zoom back

4) Show / hide focus rectangle. Activate the focus rectangle (10) to zoom in on a particular area in he color spectrum. A magnification of the focused area is shown in the zoom window, to the right of the color spectrum (D). The size of the focus rectangle can be changed by pointing at the "extra" handle in the lower right corner of the rectangle and dragging to the desired rectangle size. Harmonics are always shown. Sidebands can be activated by the user.

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5) Zoom in / out in the color scale to emphasize colors in the spectrum

6) Spectrum information field: when you hover the mouse over the color spectrum, or when the focus rectangle is activated, details about the spectrum currently pointed at (or in focus) is displayed here.

7) Show / hide RPM/symtom list, Zoom window and individual spectrum

8) Show / hide zoom window

9) Show / hide individual spectrum

B) **Color spectrum**: Occupying the major part of the **Colored Spectrum Overview** window, this is the collection of spectrums under the measuring assignment. Comments are shown below the graph as small, colored squares which can be clicked on the display or edit the comment. Click on 'X Orders', 'X Hz' or 'X CPM' on the Y axis (11) to toggle between them. Right click in the color spectrum for a popup menu with further options.

C) **RPM/symptom list**: This is a list of the symptoms etc. set up on the measuring point. Mark one to display RPM and symptom values (F) for the current measuring result. Matching symptoms for the current position in the color spectrum are indicated with red arrows in the list and in the color spectrum, or blue arrows for theoretical matches.

D) **Zoom window**: Shows a magnification of the spectrum currently pointed at (or in focus) in the color spectrum. The bluish grey arrows on each side indicate the highest value and its sidebands (if any).

E) **Line graph**: The trend curve of the spectrum currently pointed at (or in focus) is displayed immediately below the color spectrum. The current center position in the color spectrum is indicated with two bluish grey arrows.

F) **Symptom graph**: The trend curve of the RPM or symptom currently marked in the RPM/symptom list is displayed in the lowermost part of the **Colored Spectrum Overview** window.

G) **Individual spectrum**: In the lower right corner of the **Colored Spectrum Overview** window, the spectrum corresponding to the measuring result currently in focus is displayed. Under the '**...**' button, the display of theoretical lines can be turned on or off.

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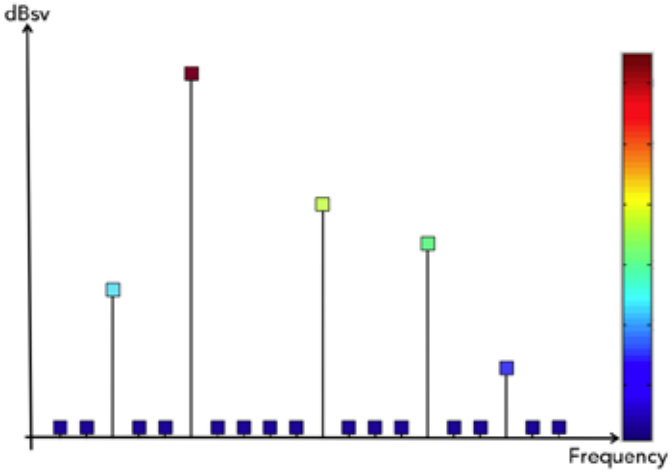
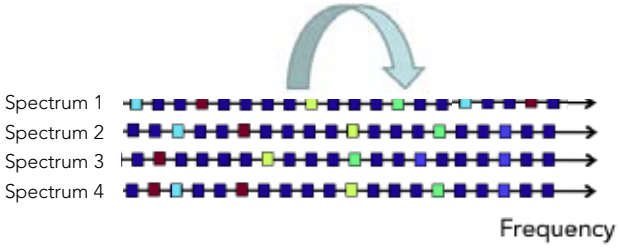
How the colored spectrum overview is created

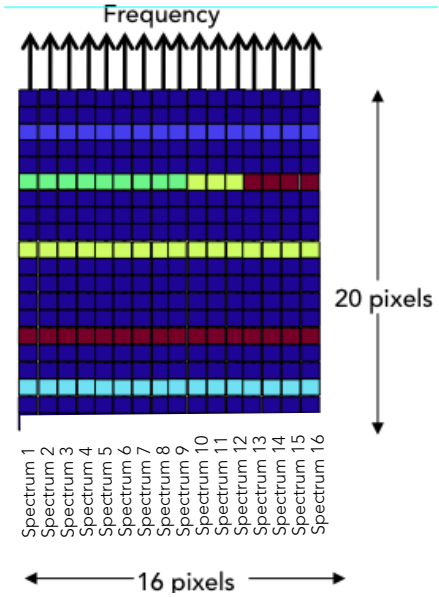
1. On all spectrums under the selected measuring assignment, amplitude is translated into a relative color scale:



2. The spectrums are "piled up" into a stack, then the whole lot is turned upwards and displayed from above:



3. The result can be thought of as a topographic map, only here the tightest contour (or altitude) lines correspond to the color red:



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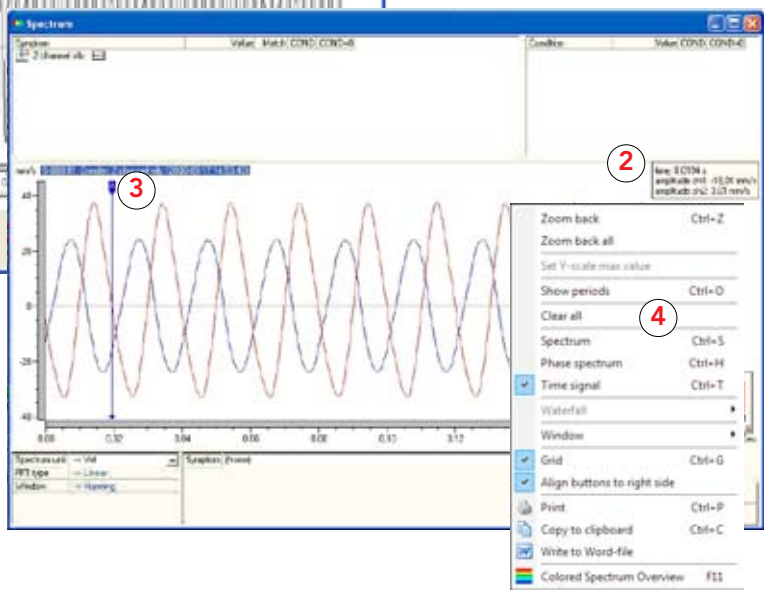
Left:
Time signal

- One channel
- No RPM
- One marker

Time and amplitude displayed in popup window (1).



Right:
Time signal

- Two channels
- No RPM
- One marker

Time and amplitudes displayed in popup window (2).

Evaluating two-channel measurement results

The examples above illustrate the differences between one and two-channel spectrums. In the above cases, the respective spectrums will look the same whether or not RPM was input.

In the spectrum and the time signal, the channels are superimposed, channel one in blue and channel two in red.

Marker A (3) is displayed by briefly holding down the left mouse key in the graph. The marker can then be positioned anywhere in the graph by clicking the marker tab while at the same time holding down the left mouse key and dragging the marker to the desired place.

A small popup window (1, 2) then displays the time for the measurement and the amplitudes for the channel(s).

A right hand click opens the dropdown menu (4) where you can select background grid, show harmonics or sidebands, change scales etc.

A two-channel phase spectrum can also be viewed after measurement. The phase spectrum displays the channel 1 phase minus the channel 2 phase. At values beyond ± 180°, 180° is added/subtracted. The scale shows -180° to + 180° (applicable to Machine Evaluator only).

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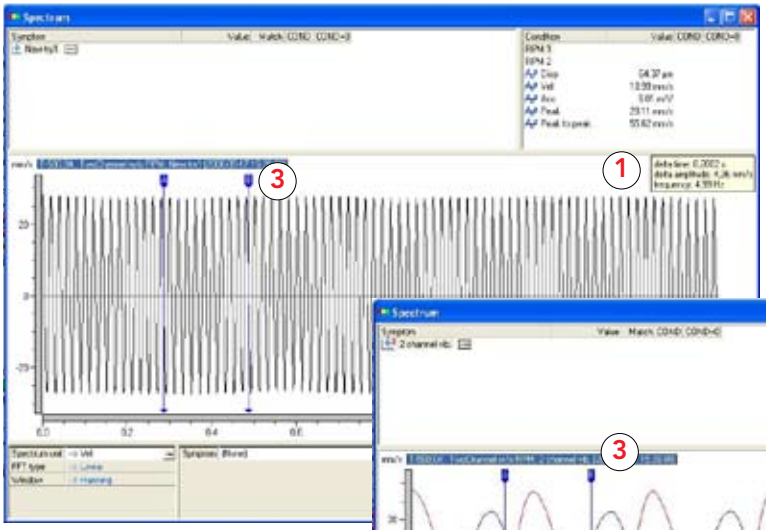
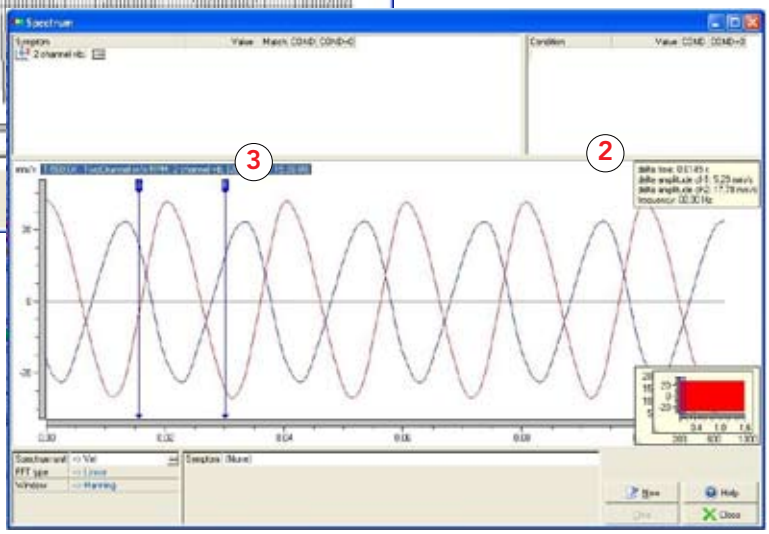


Left:
Time signal

- One channel
- No RPM
- Two markers

Delta value and frequency displayed in popup window (1).



Right:
Time signal

- Two channels
- No RPM
- Two markers

Delta values and frequency displayed in popup window (2).

Evaluating two-channel measurement results

Marker B (3) is displayed by briefly and simultaneously holding down SHIFT on the keyboard and the left mouse key in the graph. The marker can then be positioned anywhere in the graph by clicking the marker tab while at the same time holding down the left mouse key and dragging the marker to the desired place.

The popup window (1, 2) then displays delta values for time and amplitude for the channel(s). Frequency is also shown. With no RPM value present, phase angle cannot be displayed.

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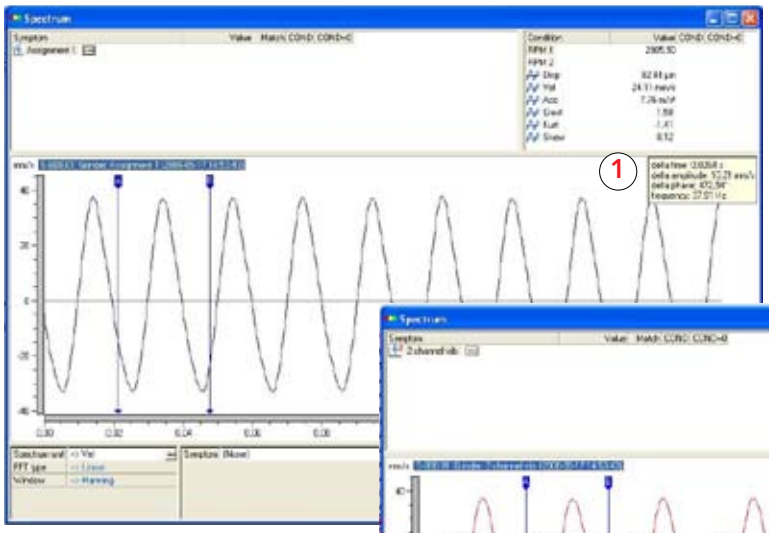
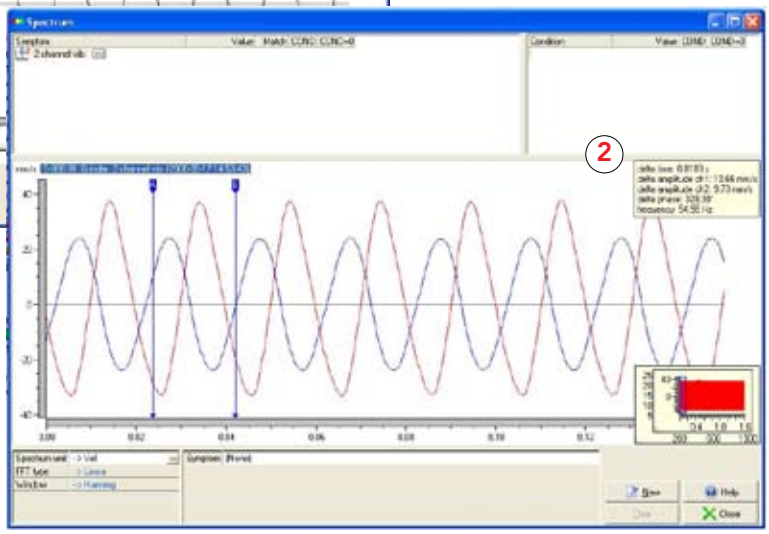


Left:
Time signal

- One channel
- RPM
- Two markers

Delta values, phase angle and frequency displayed in popup window (1).



Right:
Time signal

- Two channels
- RPM
- Two markers

Delta values, phase angle and frequency displayed in popup window (2).

Evaluating two-channel measurement results

In these examples, RPM is included in the measuring assignment. The two markers therefore also show the difference in phase angle (delta phase) at the actual frequency.

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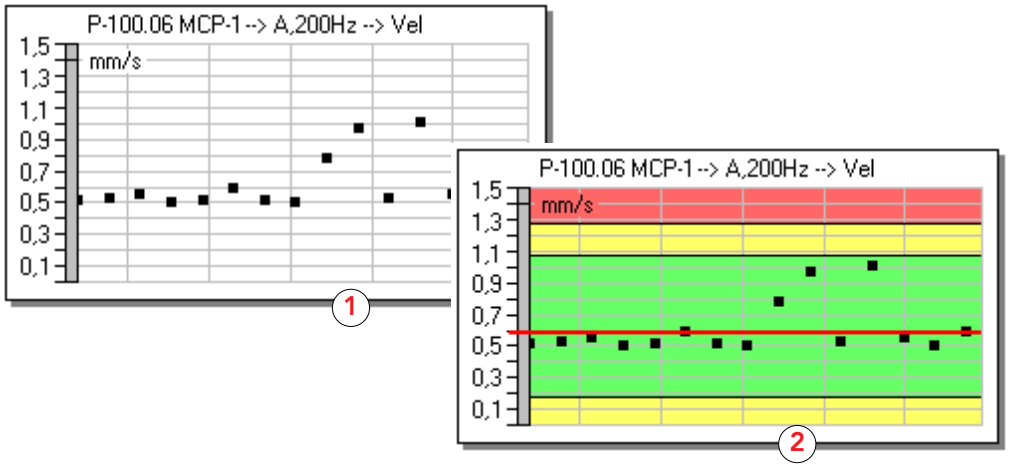

Criterion calculation:

- A criterion is based on a defined set of measurements (1)
- The green - yellow - red condition zones depend on mean value and standard deviation (2)

The evaluation of EVAM readings

Looking at spectra and studying the trends of condition parameters may, on occasion, be useful, but it does not provide you with the fast condition analysis needed for efficient condition monitoring. Both the Timken method and vibration severity measurements (VIB) work with general evaluation standards which apply to all bearings of a type (Timken evaluation) or all machines of a class (ISO standard). These only need fine tuning for exceptional applications.

EVAM readings need an individual evaluation, based on the vibration readings (1) from a specific machine or even a specific measuring point. Only experience can show whether the same evaluation standard can be applied to several similar machines.

The evaluation of EVAM parameters is based on statistics: the mean value and standard deviation (2) obtained from a number of representative vibration readings. The readings should cover the whole range of normal operating conditions (speed, load, temperature, etc.) that affect the machine's vibration behaviour, because you will get a "bad condition" indication whenever a reading falls outside of the normal range, and this can either be due to abnormal machine vibration (which you try to detect) or too narrow a base.

A specific set of evaluation data is called a criterion. The calculations are automatically made by Condmaster Nova, all you have to do is select the vibration readings to be included.

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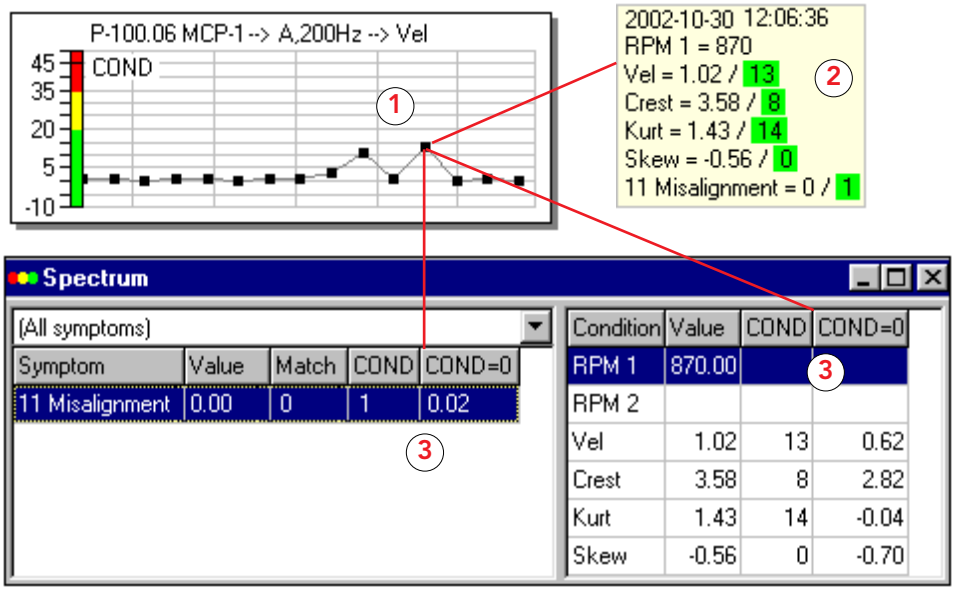

COND numbers in graphic evaluation and spectrum:

- COND no. graph for every condition and symptom parameter (1)
- Click on measurement to see evaluated parameters (2)
- COND nos. and value for COND = 0 in the spectrum (3)

COND numbers in graphics and spectrum

The result of the application of a criterion is a non-dimensional COND no. (condition number) for each active condition parameter and symptom. In Graphic evaluation, you can switch from a raw value diagram to a COND no. diagram (1), or activate both. You can click on any measuring result in an EVAM diagram and see all parameter values plus their COND nos. marked in green - yellow - red (2).

In the spectrum, you now see the parameter value plus the corresponding COND no. You also get the mean value of the measurements belonging to the criterion, under COND = 0 (3).

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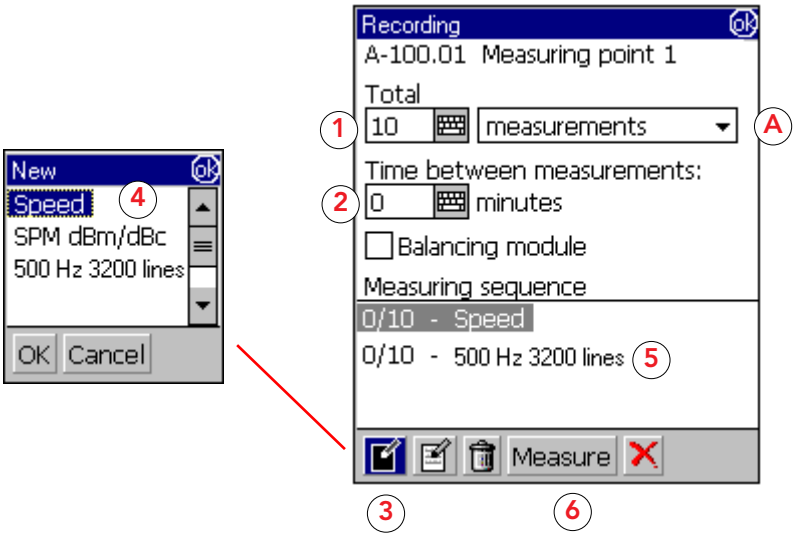

Recording set:

- Open the measuring point, click "**...**" and select **Recording**.
- Set number of measurements (1), measuring interval (2).
- Click **New** (3), select technique (4). Start recording with **MEASURE** (6).

Recording a batch of EVAM readings for the Machine Evaluators

To make an adequate criterion for the evaluation of EVAM measuring results, you have to obtain vibration readings covering the whole range of normal operating conditions of a specific machine. This may take considerable time. A practical way to start is the function "Recording" in the Machine Evaluators, which allows you to quickly collect a set of data for a preliminary criterion. Please note that this is a shortcut, not likely to provide a very accurate base for correct machine condition evaluation, but it gives you a starting position and you can – and should – make a more appropriate criterion once you have sufficient data.

Download a single measuring point or round to Machine Evaluator and open it. Select RECORDING from the menu under •••.

You can record a stated number of measurements at stated intervals, or measure for a stated number of minutes. The field (A) toggles between 'measurements' and 'minutes'.

Input the number of measurements (1) and the time interval (2). "0" in the time field means "as fast as possible". Use the key **NEW** (3) to put the measuring technique on the list under **Measuring sequence** (5). EVAM assignments are listed by name. Connect the transducer and use **MEASURE** (6) to start.

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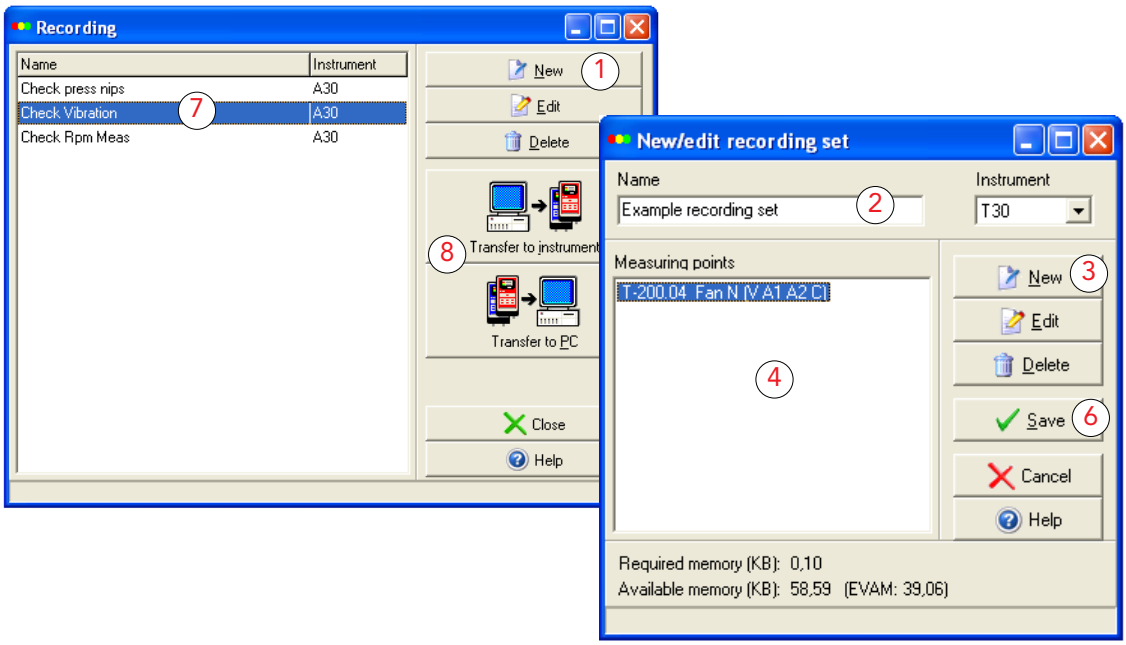

Recording set:

- Click **NEW** (1), input name and select instrument (2)
- Click **NEW** (3) and, after data definition, save (6). Transfer (8).

Recording a batch of EVAM readings for the Machine Tester

For Machine Tester, "Recording" is similar to making a round and using **Data transfer**. Open "Recording" and click **NEW** (1). This brings you to the editing form where you input a name for the set and select the instrument (2). Click **NEW** (3) on this form to define measuring points and measurements. Each measuring point will be listed on the edit fo rm (4). At the bottom of the form the required memory for the measurement is displayed (5). You will get a warning in case the instrument capacity is exceeded. Save the set (6).

Set name and instrument are listed on the recording form (7). Download/upload as with a measuring round (8).

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Shock pulse, dBm/dBc
Shock pulse, LR/HR
SPM Spectrum

Vibration, all techniques
or
analog (current, voltage)

Rotational speed
or
temperature

Recording with several transducers:
Combine up to three different measuring techniques.

Applications for the Machine Evaluator recording function

A recording set for Machine Evaluator consist of one measuring point and up to three different measuring techniques (counting all shock pulse techniques as one). Thus you can measure several quantities almost simultaneously and study the interaction between them.

A typical application for vibration measurement are run-up and run-down controls on machines that change their vibration behaviour during the starting and stopping period. Use spectrum settings with short acquisition times and measure "as fast as possible".

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The Condition Manager

What used to be called the Criteria Guide in earlier Condmaster versions has had a complete makeover in order to allow greater flexibility in alarm configuration. The new **Condition Manager** is a general improvement applicable to EVAM, SPM Spectrum SL and SPM HD readings obtained with any Timken measuring device (flexible condition evaluation is not applicable to ISO2372/10816 measurement, where alarm limits are defined by the ISO standards).

Furthermore, users of the OIS online system can now use *machine operting conditions* such as power, flow or pressure as criteria to determine equipment running condition (for further information on the use of machine operating conditions in OIS, please see section '*Machine operating conditions*').

Alarm options

Over the years, Condmaster alarm options have evolved and by the Condmaster Nova 2008 version, they included:

- *Level alarms*, i.e. an alert or alarm is triggered whenever a measured parameter reaches a certain, user defined threshold. This type of alarm is static and therefore works well on applications running with fixed speed and stable loads.
- *Moving average alarms*; essentially the same as above but the value triggering the alarm is a calculated average of a user defined number of measuring results rather than one individual reading. With moving average, alarms caused by sudden and random amplitude increases are avoided. The system calculates a mean value of *x* number of readings and calculates a new mean every time a new reading is registered. The higher the number of readings for mean calculation, the flatter the resulting curve will be. Moving average alarms are preferably used on applications subjected to randomly high readings from unexpected events.
- *Bands (single, multiple and octave)*: In a spectrum, the use of bands is an efficient way of isolating symptom frequencies from each other. The RMS value of all the amplitudes within a user defined frequency range are then added to each other, resulting in a bar graph of the energy contained in the different frequency bands (for more information on bands, please see document no. 71877, *What's new in Condmaster Nova 2008*).
- *Criteria Guide*, used to create alarm limits based on a statistical computation of multiple measuring results from machinery in good running condition.

All of these alarm options are available also in the 2010 Condmaster Nova version, but as mentioned above, the new Condition Manager replaces the former Criteria Guide.

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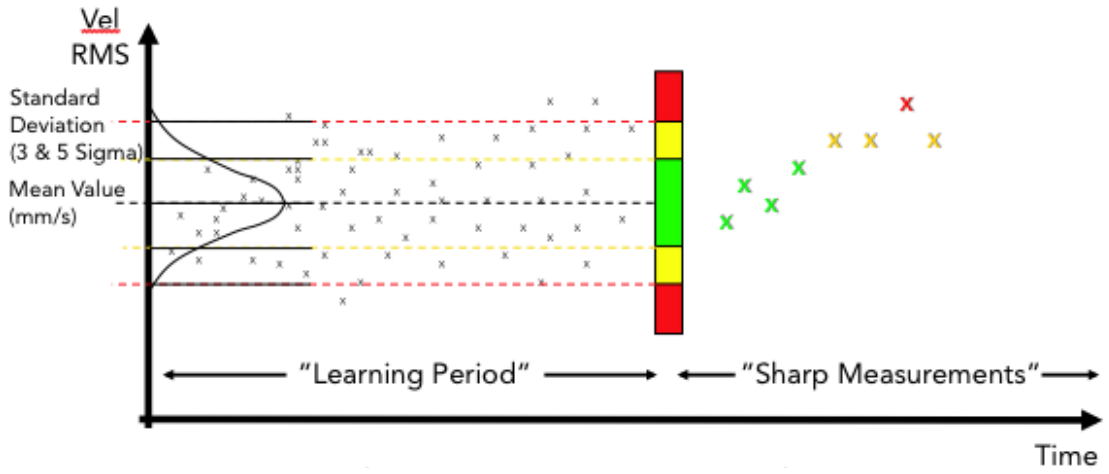
The Condition Manager enables users to experiment freely in order to find the optimal alarm setup for any given application. This "learning phase" can continue until the criteria is saved. When it is saved, the criteria is activated and Condmaster starts to evaluate measuring results according to the criteria setup. If at some later time it turns out the alarm settings yield unsatisfactory results, you can always go back and edit the criteria.

What is a criteria?

A criteria is based on a specific, user selected set of measurement data. In order to obtain "representative" baseline readings on which to base condition statistics, this selection should be composed of readings from machinery in good running condition. The calculation of condition statistics is automatically made by Condmaster Nova, all you have to do is select a suitable set of readings to be included.

Condmaster calculates the mean value and standard deviation obtained from the selected set of readings. The readings should cover the whole range of normal operating conditions (speed, load, temperature, etc.) that affect the machine's vibration behaviour, because you will get a "bad condition" indication whenever a reading falls outside of the normal range, and this can either be due to abnormal machine vibration or too narrow a base.



Criterias are used to define alarm limits based on running and/or operating condition. This is also known as flexible condition evaluation, meaning that current operating conditions determine whether or not a measurement value merits an alert (yellow condition) or alarm (red condition). A high vibration reading taken under certain operating conditions may not necessarily mean the same as an identical result when operating conditions are different. Because it allows the setup of variable evaluation schemes, flexible condition evaluation is useful for applications such as wind turbines or extruders, which run under variable operating conditions.

The result of criteria calculation is a non-dimensional **COND no.** (condition number) for each condition parameter (VEL, ACC, DISP, Crest etc.) and symptom (unbalance, BPFO, gear mesh etc.). COND no. = 0 (zero) represents the mean value of the readings selected. Criterias are handled individually for each symptom and therefore can provide more precise alarm limits for every symptom. Selection of measuring results to include in the calculation of criteria is done using click-and-drag directly in various graphs.

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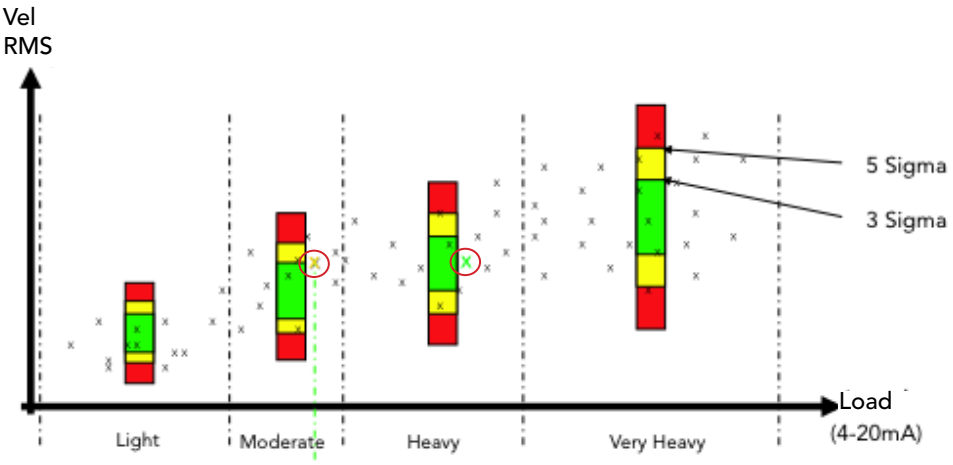
Criteria Guide vs. Condition Manager

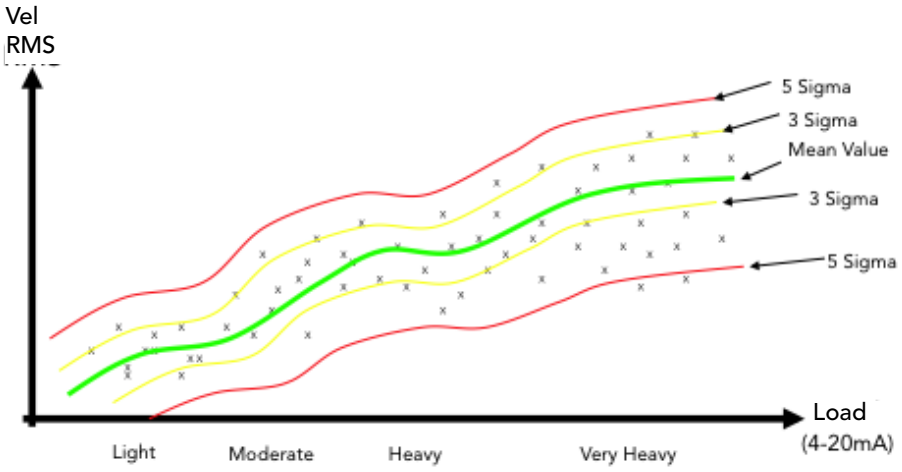
The difference between the Criteria Guide in Condmaster Nova 2008 (and older versions) and the new Condition Manager is significant.

In previous Condmaster versions, criteria calculation was made on the measuring point level, meaning all measuring results from the selected time period(s) were included in the computation. The user had no means of selecting a representative "subset" of readings on individual assignments, condition parameters or symptoms for inclusion in criteria calculation. The result was a "stairlike" evaluation of measuring results, where the same value might result in different condition evaluation depending on load, for example:



***Example**: A particular measuring result, measured under "moderate" conditions, might evaluate to yellow condition. Depending on the influence of load, the same value measured under "heavy" conditions might evaluate to green.*

In comparison, the Condition Manager gives the user full flexibility in terms of what to include in criteria calculation. Individual measuring results, condition parameters and/or symptoms can be easily selected from graphs and the result is an immediate graphical presentation. The Condition Manager yields a smoother "evaluation curve":



Example: The Condition Manager yields a smoother curve.

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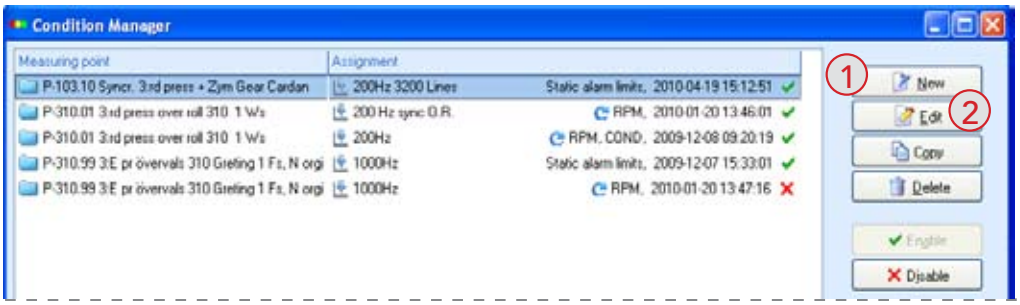
Creating and editing criteria

The Condition Manager is accessed via **Maintenance** > **Condition Manager** in the Condmaster menu bar, or via the **Alarm limit guide** in the **Measuring Point data** form. The main **Condition Manager** window lists all existing criteria:



1. Click the **NEW** button (1), or mark an existing criteria and click **EDIT** (2).
2. The Condition Manager displays the Measuring Point tree. Select a measuring assignment on which to base the criteria. Note that only one measuring assignment can be selected here; however, in the final step of the guide, more measuring results from the same and other measuring assignments can be added for the sake of improving statistics.
3. Select a **Criteria type**. Criteria may be one of two types:
   - **Static** criteria means that alarm limits will remain the same regardless of operating condition. For static criteria, the result of the statistical computation is a *normal distribution graph* (also known as a bell curve; turn the page for an example), which is a bar graph summarizing groups of measuring results representing the amount of variation in the readings. It visually represents the amount of variation in your selection of measuring results and allows you to see how many readings fall within a certain range. It will help you determine whether a particular reading fits into the bigger picture.
   - Criteria type **RPM** (or a process parameter in OIS) means alarm limits will vary with operating condition, i.e. the present value of its controlling parameter (power, speed, flow, pressure etc.). Selecting a process parameter results in a combined graph, with symptom units on the Y axis and RPM or process parameters on the X axis.
4. Now select what alarm limits are to be included in the criteria.
5. Select an alarm limit type:
   - **COND** means the result is a COND value where 0 represents the average of all measuring results included in the criteria. Alarm limits will be fixed to +21 for upper alerts (yellow) and +35 for upper alarms (red). The lower limits will be fixed to -21 for alerts (yellow) and -35 for alarms (red).
   - **Symptom value** represents the actual value of the alarm limit, e.g. 1.22 mm/sec for upper alert.
6. In the final step of the Criteria Manager, all measuring results belonging to the measuring assignment are shown. This is where you should *be careful to make a representative selection of results* to base your criteria on. Use click-and-drag in any of the graphs to select measuring results, then click the **MARK** button in the upper left corner of the form.
7. To calculate the criteria, click the **CALCULATE** button.

Please see the following pages for a description of the functionality in the graphs.

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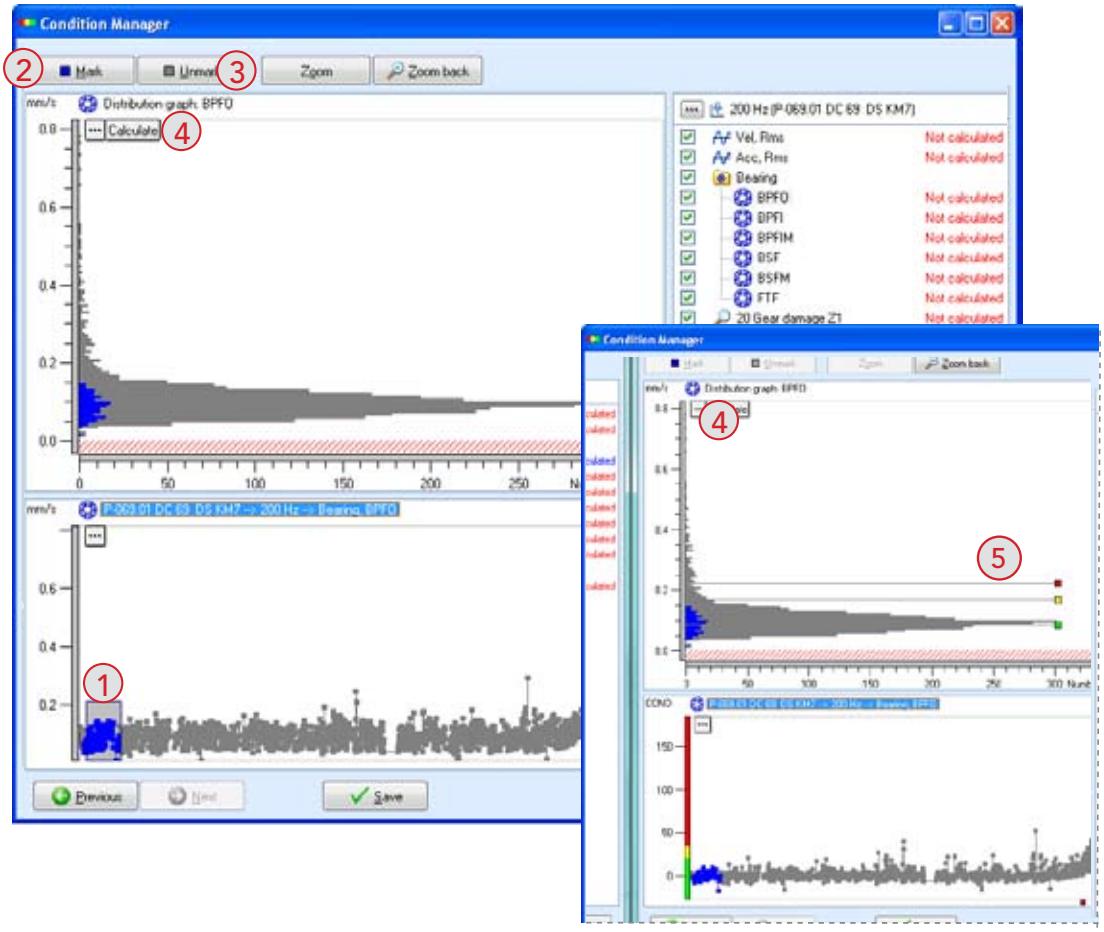
Distribution graph example

Below is an example of the final step of the Condition Manager. In the previous steps of the guide, the following settings were made:

- Criteria type = **Static**
- Alarm limits = **Upper alarm**, **Upper alert**
- Alarm limit type = **Symptom value**



As a result of selecting the **Static** criteria type, the graph is a distribution graph. In this example, a number of measuring results have been selected by the user through a click-and-drag operation in the lower graph. The selected measuring results are represented by the grey, rectangular area (1). These results will be included in the statistical criteria computation, but the computation itself is yet to be done.

1. In the lower graph, multiple "areas" of measuring results can be selected using click-and-drag. For each selection of results, click the **MARK** button in the upper left corner of the window (2). The selection of readings then turns blue in both graphs.
2. To delete unwanted measuring results from the computation, click and drag, then click the **UNMARK** button (3).
3. When you're done selecting measuring results, click the **CALCULATE** button in the upper left corner of the upper graph (4). Following this action, a green-yellow-red evaluation scale is automatically displayed in both graphs (5, see inset), showing what readings are considered to fall under "good operating condition".

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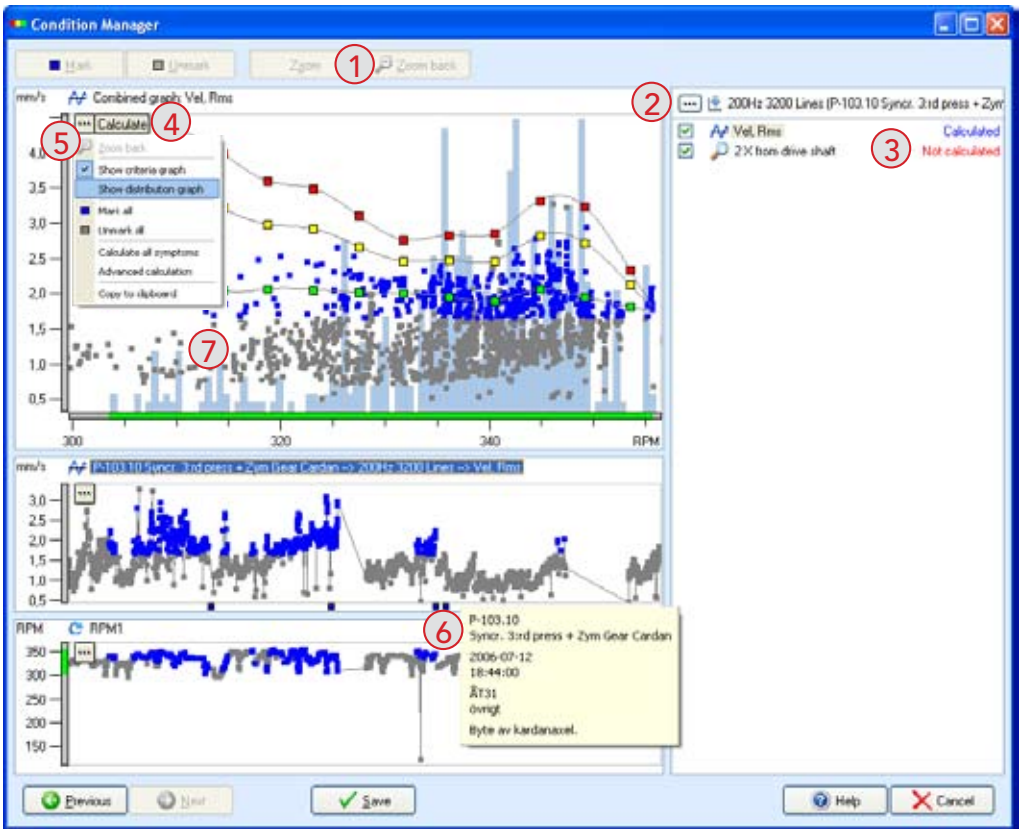
Combined graph example

Here is another example, this time with the following settings:

- Criteria type = **RPM** (process parameter)
- Alarm limits = **Upper alarm**, **Upper alert**
- Alarm limit type = **COND**



Condition guide functions

Once the criteria calculation has been done, there are a number of practical functions to help you work with the criteria:

- Zooming: Click-and-drag to mark an area in the graph(s), then click the **ZOOM** / **ZOOM BACK** buttons (1).
- Adding more measuring results: click the '**...**' button (2) to add measuring results from other measuring assignments.
- Viewing single symptoms or condition parameters: Tick the checkboxes for symptoms or condition parameters (3) to view them individually.
- Calculate criteria for individual symptoms or condition parameters: Tick the checkboxes for symptoms or condition parameters (3), then click **CALCULATE** (4). Use **Calculate all symptoms** on the '**...**' popup menu (5) to include all of them.
- Viewing comments: Click the small squares at the bottom of the graphs (6) to display comments made on the measuring point (if any).
- Moving alarm limits manually: position the cursor on any of the green, yellow or red squares (7). The cursor turns into a two-way arrow and the alarm limit can be moved up or down.

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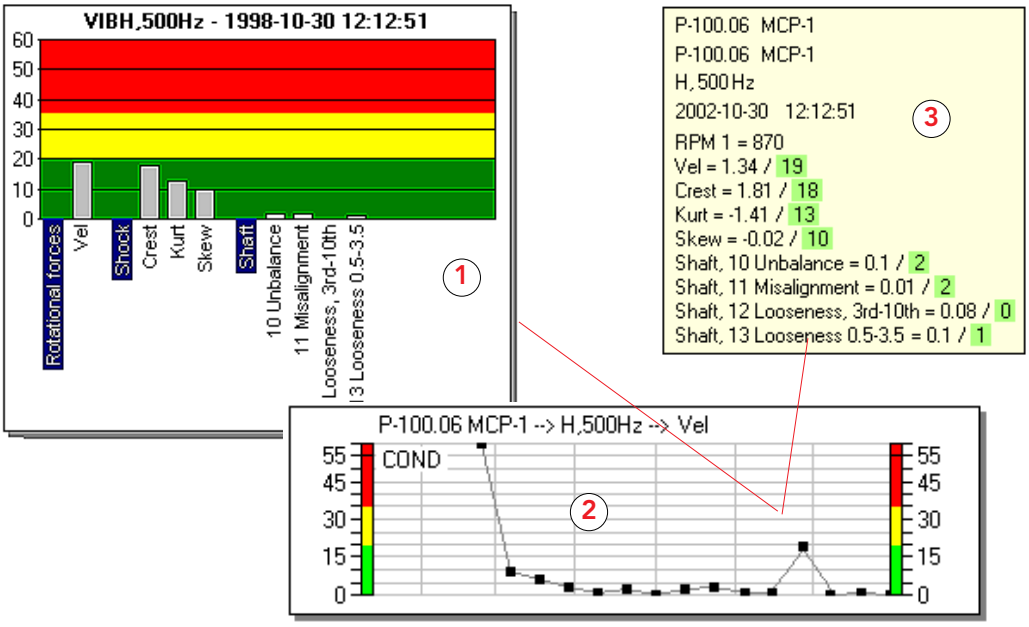

Display of evaluated EVAM results:

- Latest results shown in Graphical Overview (1)
- Any result (3) in Graphic Evaluation (2) when clicking on the dot

Display of evaluated EVAM results

The COND nos. for EVAM parameters are displayed with color coding in several places:

- for the latest measuring result in the Graphical Overview at the assignment level. Click all the way down to see each active condition and symptom parameter as a staple against a green - yellow - red background.
- for the selected range of measuring results in the Graphic evaluation, with green - yellow - red scales. You also get the color code on the dots on your folders.
- for the measuring result you click on in the Graphic evaluation, as a list of parameter values plus COND nos. highlighted in green, yellow, or red.

This gives you a very fast and efficient tool for evaluating machine vibration. However, you must learn how to read the COND number displays correctly and judge them against the data set on which you have based your criterion. The following pages give you examples.

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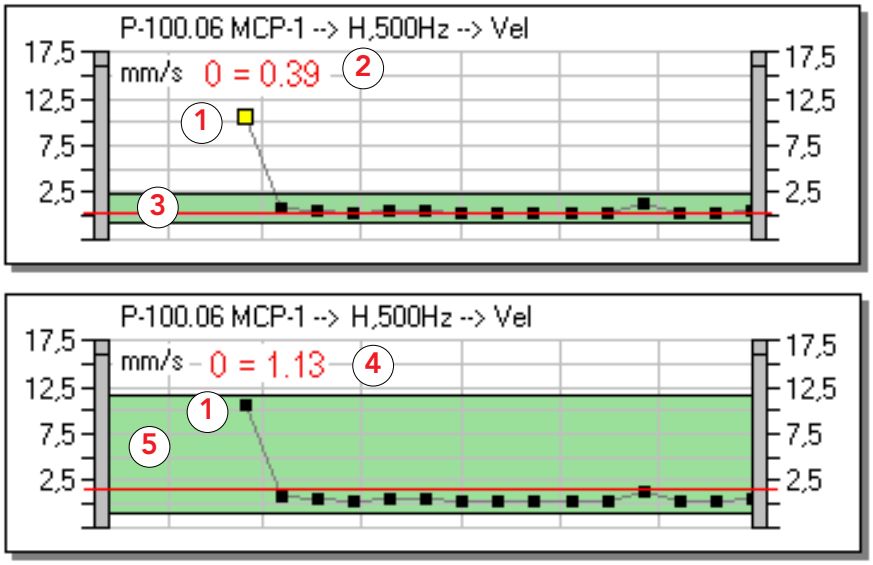

Same data, different selection:

- High value (1) excluded: lower mean value (2), narrow spread (3)
- High value (1) included: higher mean value (4), large spread (4)

Criteria with different selection conditions

One set of data, recorded "as fast as possible", form the base of two different criteria, here called A and B. Criterion A excludes the first high VEL value (1). The remaining values are all close to 0.4 mm/s. The mean value corresponding to "COND no. = 0" is 0.39 mm/s (2). The spread of the included values (3) is very narrow, which makes the standard deviation small.

The selection for criterion B includes all measuring results, even the high value (1). The resulting mean value (4) is 1.13 mm/s. The spread of the included values (5) is much wider, which makes the standard deviation large.

The figures are taken from Graphic evaluation. The spread indication (green) and the red lines marking the mean values have been added.

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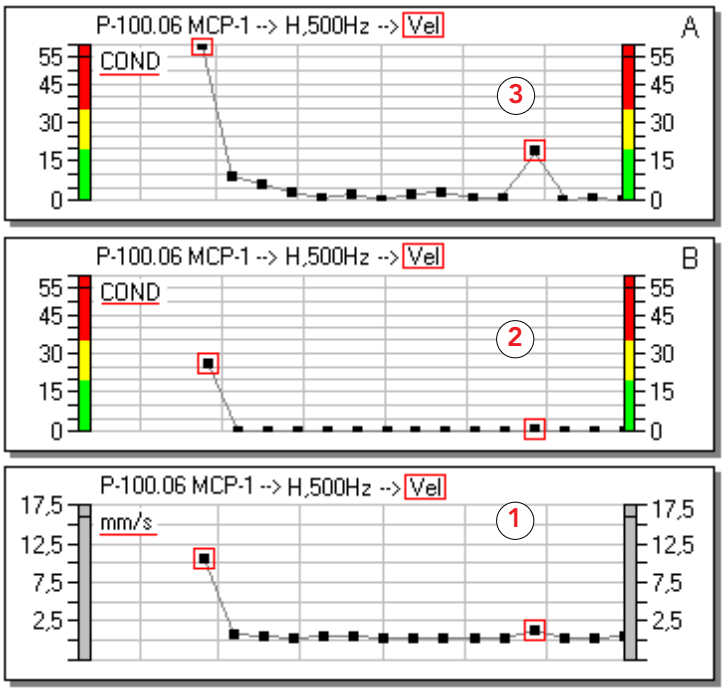

Evaluation A and B:

- A narrow data spread produces high changes in COND nos. for moderate deviations from the mean value

The effect on COND numbers

The effect of different criteria on individual COND numbers can be dramatic. The diagrams above are all based on the same facts. The lowest diagram shows straight measuring results for the condition parameter VEL, in mm/s RMS.

Diagram A is produced with the criterion A that does not include the first high value and thus has a narrow spread. Consequently, the COND no. for this first value goes right over the top (COND = 60 is the largest possible value, meaning "out of range"). Judged with criterion B, the same value is still in the yellow zone.

Another interesting part of these diagrams are the differences in evaluation at points 1, 2, and 3. There is a noticeable increase in the raw value at (1), which is almost invisible at (2) and exaggerated at (3). In fact, VEL at this point has increased from 0.27 (previous reading) to 1.34 mm/s RMS or 5 times. It is four times higher than the mean value for COND = 0, using criterion B. This is quite a big change, especially considering that the first value in the batch, 10.47 mm/s, is almost certainly a measuring fault.

Another important fact is that, although there are differences when examined point by point, the general shape of the diagrams and thus the trends are clearly the same: vibration severity is low and stable. The conclusion from this is:

- you have to think and check before making a criterion
- you must not overreact to individual high COND nos. but check the trend and the raw values.

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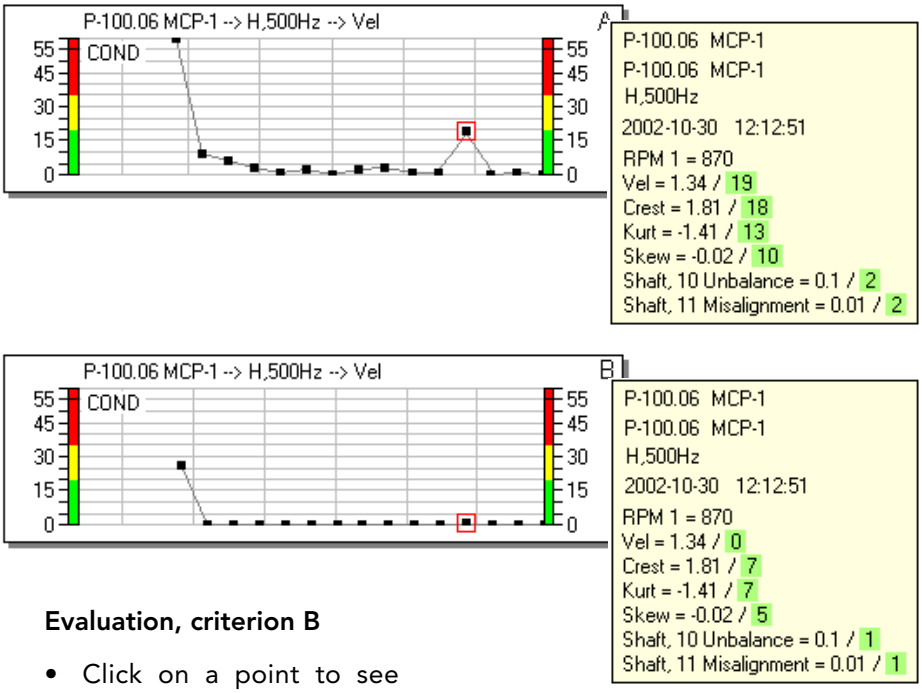

Evaluation, criterion B

- Click on a point to see parameter values

Measuring result list in graphs

The fastest way of checking a "suspect" measurement is to click on the point in a graph. This opens a list of all parameter values and the corresponding COND nos. It does not matter which parameter diagram you use, the list is always complete.

As said before, the VEL graph is most relevant for judging machine condition, so it should be the first choice.

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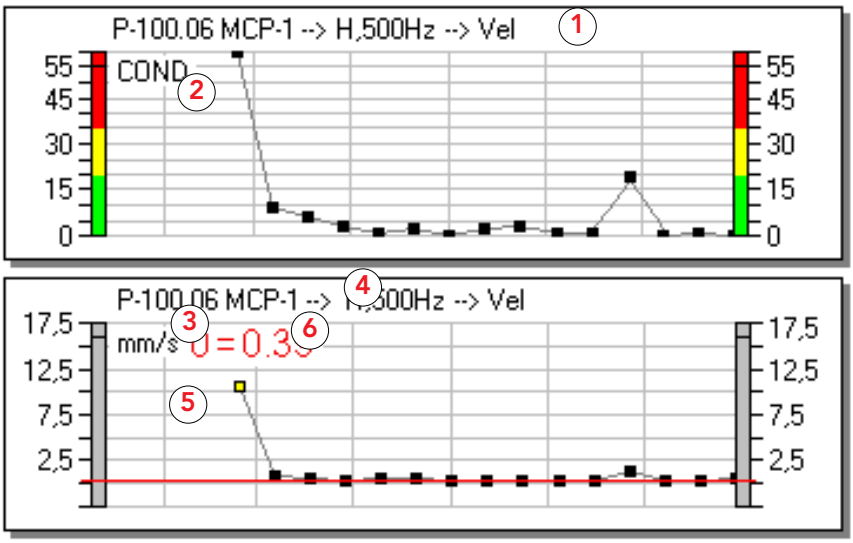

Display of COND no. and raw value

In the Graphical evaluation, you can easily copy a diagram by holding down the CTRL key while you click on the title (1). Then drag the title to the space beneath the original diagram, thus doubling it on the screen. The key F4 alternates between a COND no. diagram and a raw value diagram. The first has COND at the top left (2) and colored scales. The second has the measuring unit, if any, at the top (3) and grey scales. Thus you can place raw values beneath each COND diagram. You can do that once for a batch of diagrams and save these settings as a sequence for later recall.

This and the following example have all been produced in that manner. The following additions have been made in the figures:

- The mean value used by the criterion (displayed in the function **Spectrum**) has been written at the top left (4) and drawn across the measurements (5). The first value, not included in Criterion A, is shown in a different color. All examples use the criterion A unless they compare the results from A and B.

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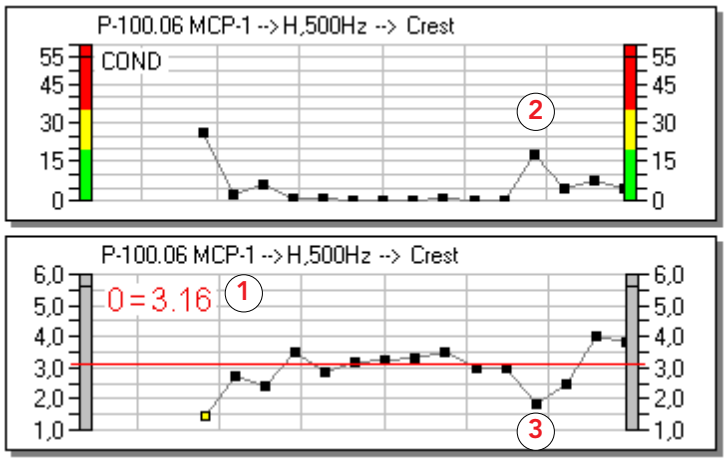
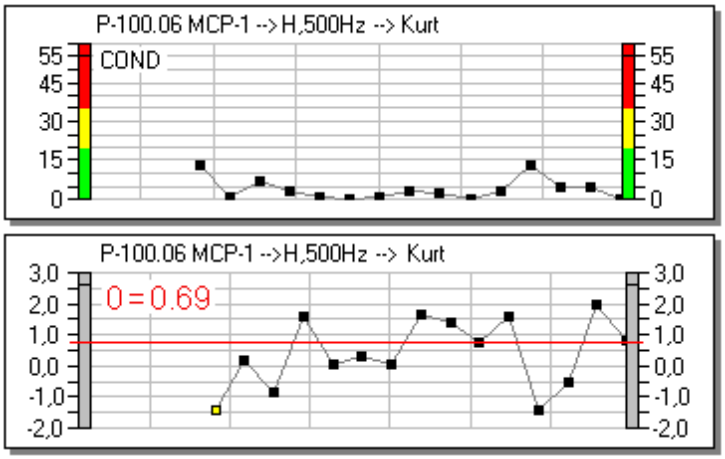


The Crest factor

When you make a criterion, the mean value and the standard deviation for each active condition parameter is calculated separately. Excluding a high VEL reading excludes the whole measurement, but that is not likely to exclude a measurement with an exceptional CREST factor. For this, you have to set a condition on CREST.

The CREST factor is the ratio between the RMS value and the peak value in a vibration velocity measurement. The diagrams show, for example at (2) and (3), that a value **below** the mean value has the same effect on the COND no. as a value **above** the mean. Thus, you have to compare COND no. and raw value graphs (or go to the measuring result list) to see whether a change in COND no. is due to an increase or a decrease of the raw value.

The CREST factor of a pure sine wave is 1.414, and normal values vary between 1.4 and 3. Transients due to shocks can cause peaks far above the RMS value: they have high amplitudes by contain little energy because they are of very short duration.



Kurtosis

CREST, KURT, and SKEW are non-dimensional. They are calculated directly from the time record during vibration measurement. They all indicate the presence of transients in the vibration signal: transients which are due to shocks. In these examples, the measuring results are "artificial", produced by knocking on the machine from different sides with a metallic object to produce shocks.

KURT describes how the vibration signal is grouped around its mean value. A pure sine wave has KURT = -1.5. The more transients in the signal and the higher their amplitude, the higher the kurtosis value.

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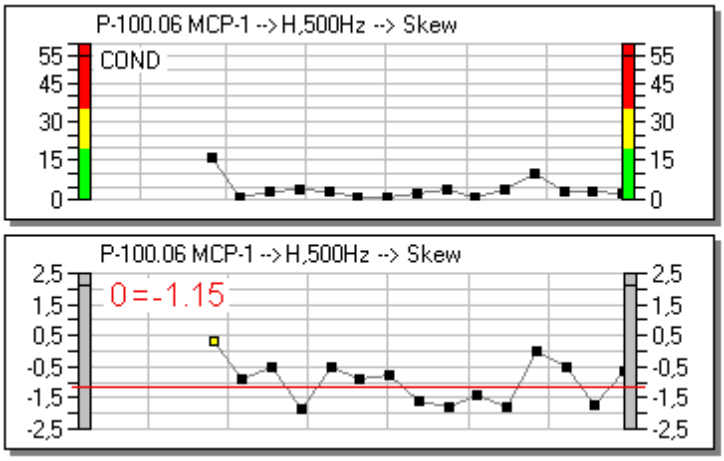
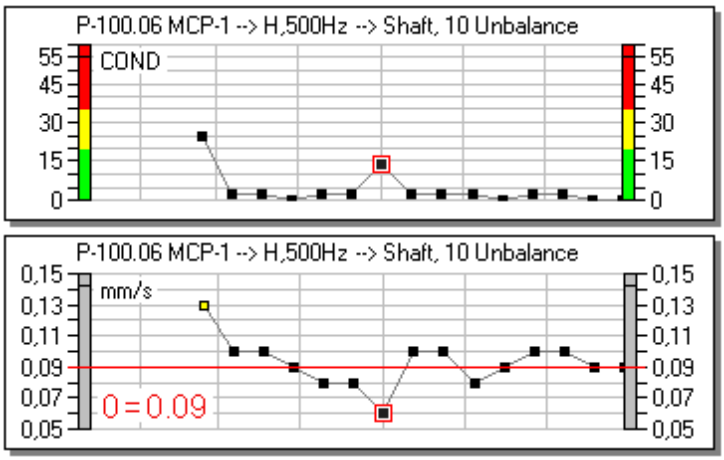


Skewness

SKEW describes the symmetry of the signal grouping around its mean value. If symmetry is perfect, SKEW = 0. The value goes from plus to minus depending in the direction of the transients in relation to the measuring direction of the transducer.

Positive transients cause a positive value, negative transients cause a negative value. Here the values change dramatically because the machine was hit from opposite sides with a metallic object during measurement.



Unbalance

When you use symptoms in an assignment, their parameter values are evaluated by the criterion in the same way as condition parameter values. The raw value is the RMS velocity value in mm/s from all matching lines in the spectrum combined. The symptom "Unbalance" has only one line, so here you see a graph of that line's amplitude. The raw symptom parameter value is 0 when that line is not present in the spectrum. For symptoms with several lines and harmonics, the values can change a lot with the number of matches found, especially when the overall vibration is low.

Note that the mean value here is very low. The only significant change in the COND no. (when we ignore the first reading) is actually due to a drop of the parameter value.

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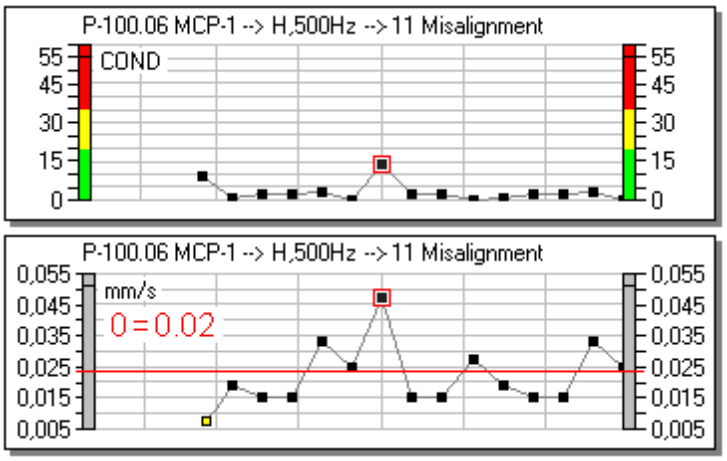
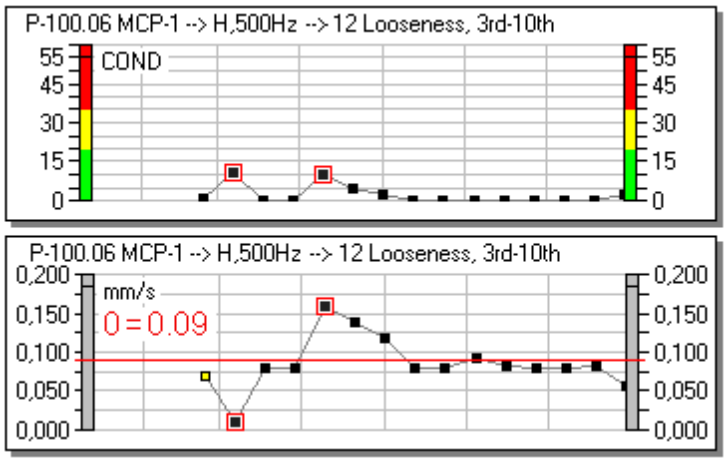


Misalignment

Misalignment values have a large spread. The mean value is extremely low, which can explain the variations: in a two line symptom, finding one or two matching lines can make a large difference.

The only significant increase in COND no. is due to an increase in the raw value.



Looseness

Again, we see a large spread and a very low mean value. The symptom consists of eight lines. The two tops in the COND no. diagram have opposite causes: the first marks a decrease, the second an increase in the measured value.

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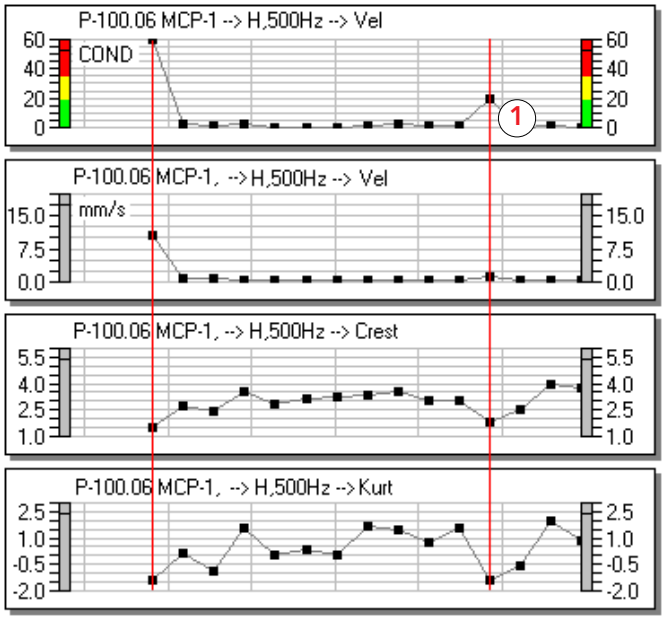

VEL, CREST and KURT

The diagrams above compare the curves for VEL (COND no. plus raw values), CREST and KURT. In both cases where VEL went up, the shock indicators went down. Thus, there was a true increase in vibration severity at (1), reflecting the greater vibration energy and not due to transient shocks.

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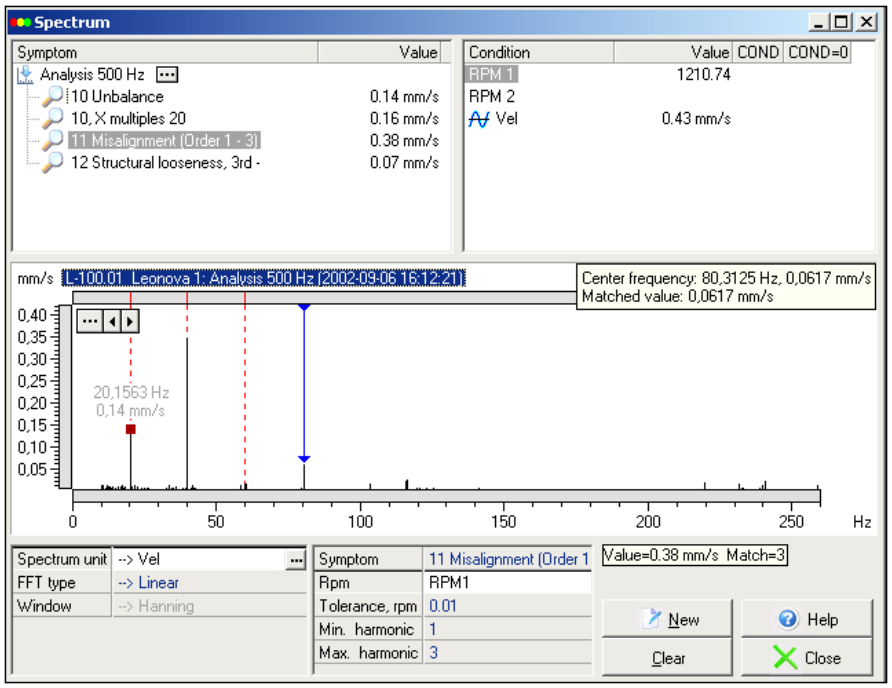

Spectrum for selected measuring result

Checking the spectrum

A right hand click on the measuring result in **Graphic evaluation** opens a menu from where you can jump directly to **Spectrum**.

This is the spectrum for the measurement discussed on the previous pages, scaled 0 to 20 mm/s. You see almost nothing because the measured vibration is very low.

Scale downwards or click anywhere in the spectrum window and mark **Logarithmic Y-scale** to get a better view.

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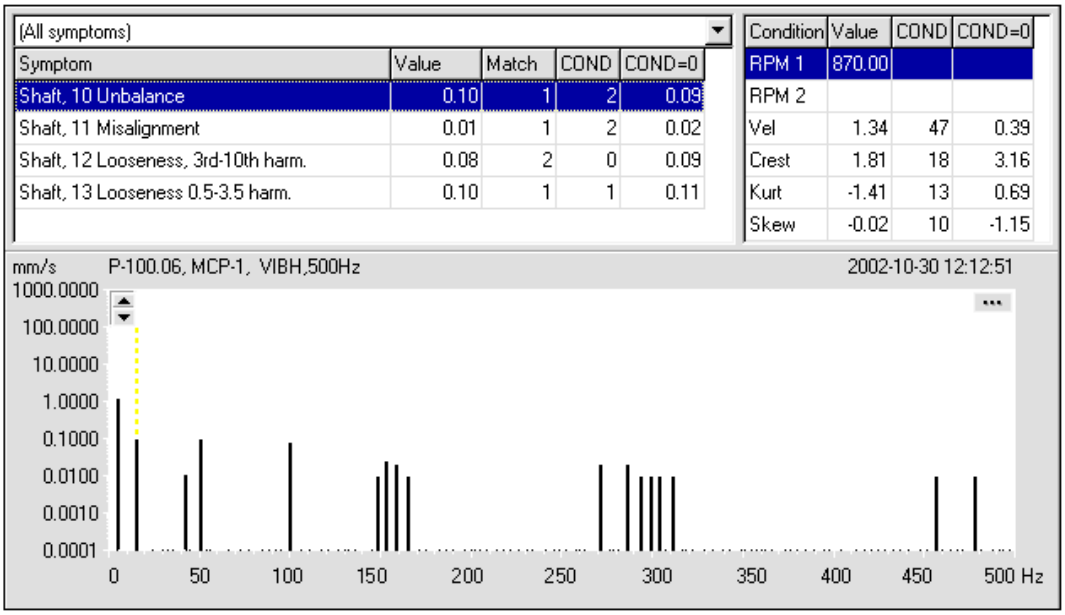

Spectrum with logarithmic Y-scale

Spectrum with logarithmic Y-scale

The magnified spectrum shows no line above≈1 mm/s and confirms the conclusion drawn from the overall low RMS values: there is nothing alarming about the vibration measurement.

Note that peak values have little influence on the spectrum when they are due to transients.

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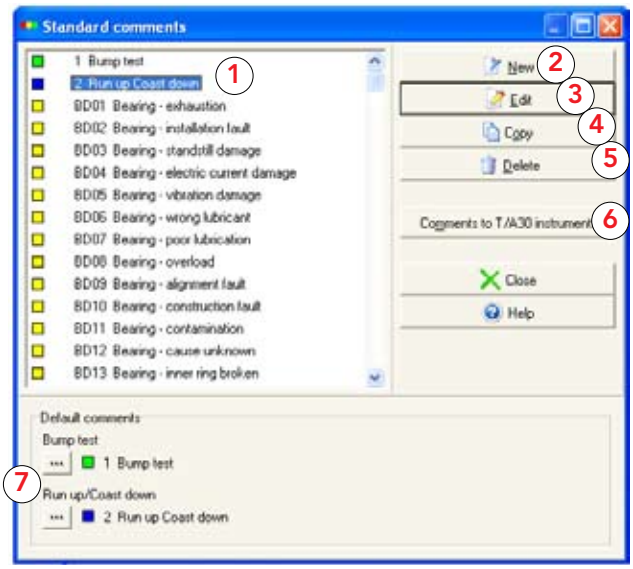

Standard comments:

- Standard comments are listed by code and name (1).
- Click **NEW** (2), **EDIT** (3), or **COPY** (4) to make changes.
- For the Machine Evaluators, all standard comments are automatically downloaded.

Working with comments

Condmaster Nova contains a register of **Standard Comments**. These are templates for comments which you can attach to a component or a measuring point and a time, to mark and explain e.g. an important measuring result or some other event you want to remember. These comments turn up as colored squares beneath the diagrams in Graphic evaluation. The report **Comment statistics** under **Printout** prints all comments in your data base together with their frequency of occurrence. You can use this report as statistics for bearing failures and other machine and maintenance faults.

A standard comment has a code and a name (1). These become part of the comment when you use it, together with measuring point (component) number, date and time and, as an option, an explanatory text.

The buttons **NEW** (2, create a new standard comment), **EDIT** (3, change an existing standard comment), and **COPY** (4, duplicate marked standard comment, edit and save under new code/name) all lead to the edit form, see next page. **DELETE** (5) removes the marked standard comment unless it is still used somewhere (old comments can be removed when making a safety copy).

Up to 16 standard comments can be selected for downloading to the Machine Tester (6), while **all** comments are automatically selected for the Machine Evaluator instruments. Every time you download a round, these standard comments automatically go with it.

In the bottom part of the window are "**...**" buttons (7) to be used for assigning default comments to the standard **Bump test** and **Run up/Coast down** comments. Before making a Bump test or Run up/Coast down measurement, download a round to Machine Evaluator, predefining what comment the instrument should use.

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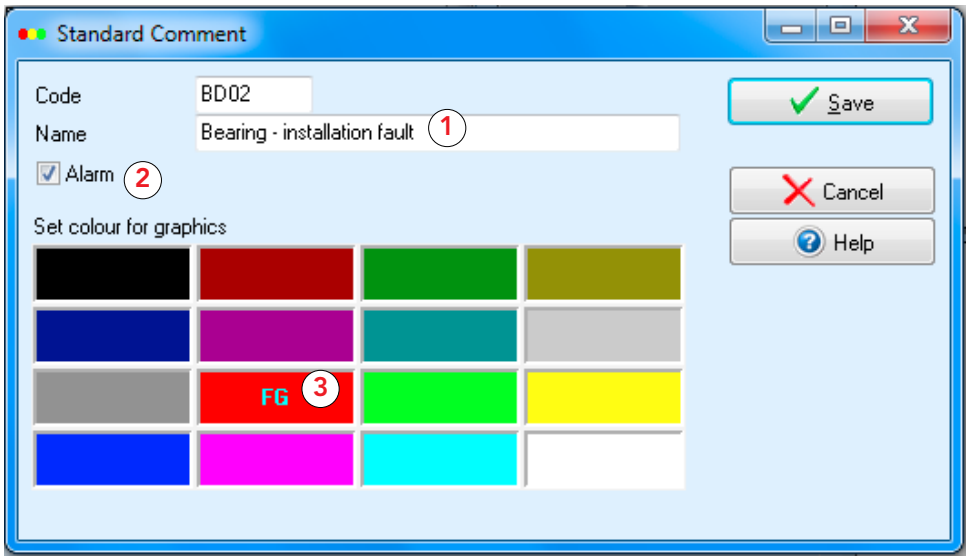

Create / edit standard comment:

- Input / edit code and name (1).
- Mark **Alarm** (2) to force alarm via the comment.
- Select color for graphics (3).

New / edit comments

A standard comment is input or changed on the edit form. Input the code (max. four characters) and the name (1). Click on a color (3) to select the color of the comment square in Graphic evaluation. The selected field is marked **FG** (foreground). **BG** (background) is always on black and has no practical effect. Black becomes the foreground color when you click on it.

A comment attached to a measuring point or component forces the item(s) onto the alarm list when **Alarm** (2) is marked for the standard comment.

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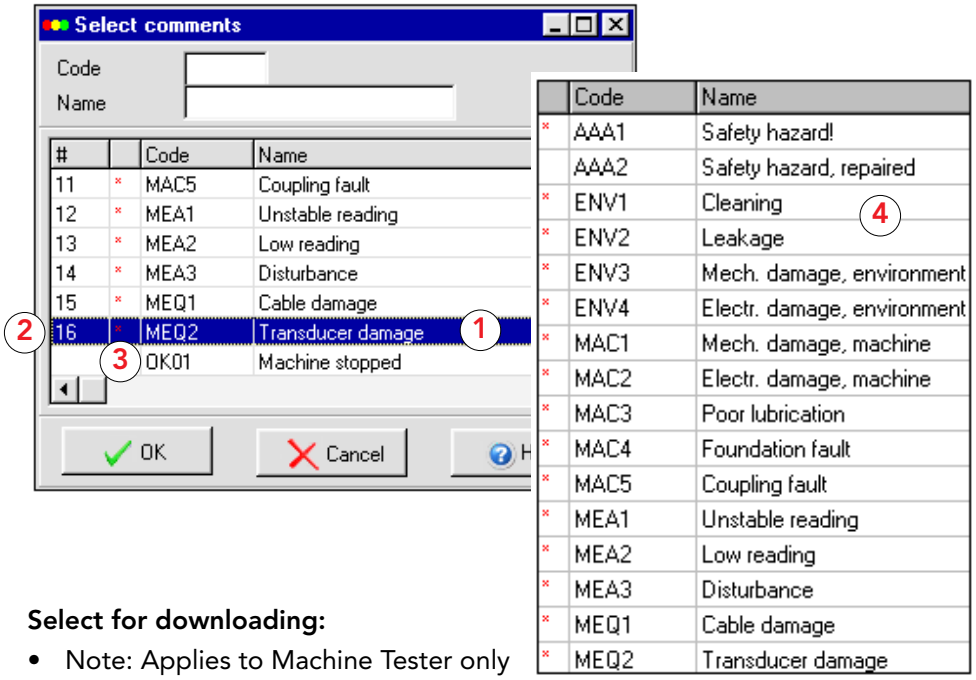

Select for downloading:

- Note: Applies to Machine Tester only
- Click on the line to select (1).
- Selected comments are numbered, max. 16 (2).
- Finish with **OK**.

Download comments to instrument

When you use a Machine Evaluator, **all** standard comments are always **automatically downloaded** with the measuring rounds. The following instructions apply only to the older data loggers Machine Testers:

Up to 16 standard comments can be selected for downloading to the data logger. Downloading is automatic every time you download a measuring round.

After taking a reading (any technique) you have the option to set a comment. It will be uploaded to the comment register and appear in the Graphic evaluation. You can then add your own text to it.

It is recommended to select standard comments which contain information that is relevant for the condition of the machines and their environment but not apparent from the measuring results, for example the comments listed above (4).

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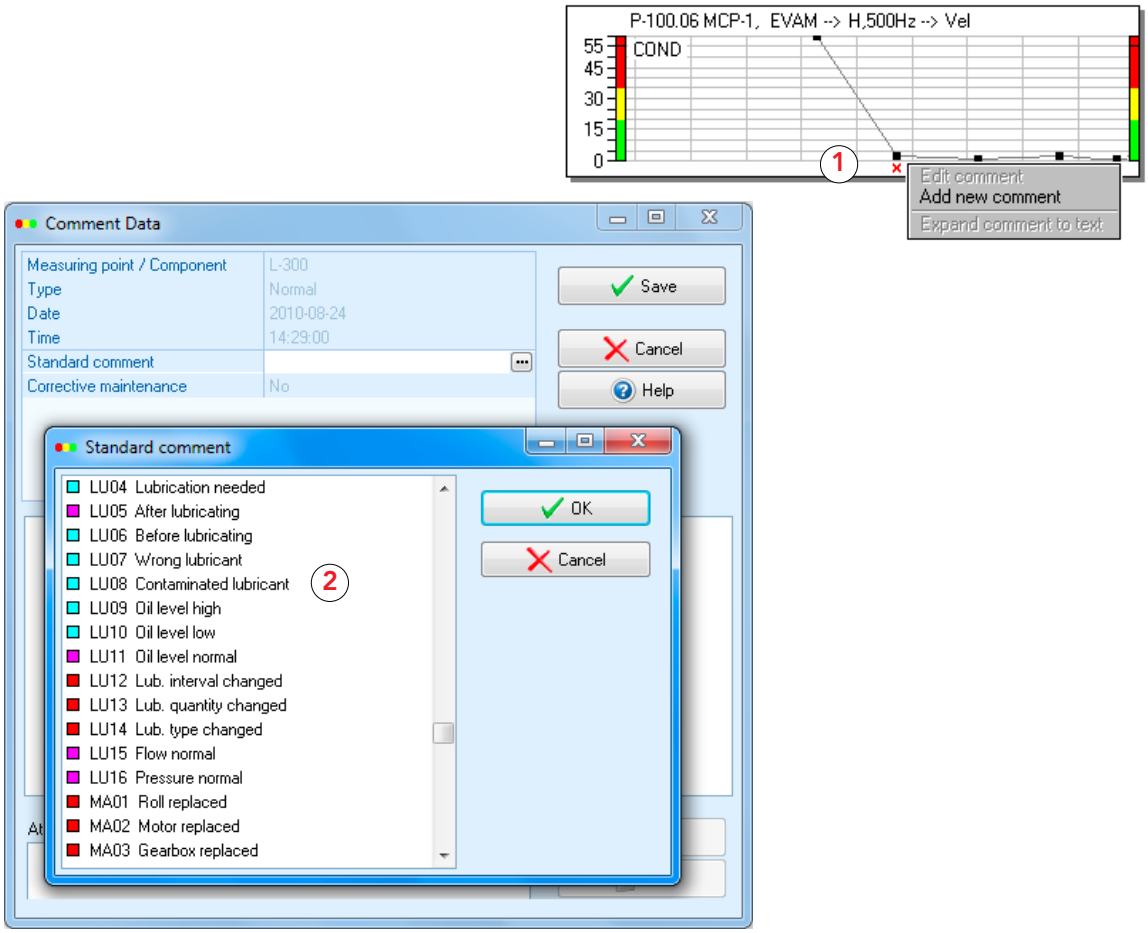

- Right hand click on the comment line below the diagram (1).
- Click **Add comment**, select standard comment (2), add text and attachments.

Set a comment in the Graphic Evaluation

In Graphic evaluation, you can right hand click on the line directly below a diagram to add a comment. First zoom in on the spot to get date and time right. Select **Add new comment**. This opens the standard comment register (see next page) where you mark the comment (2).

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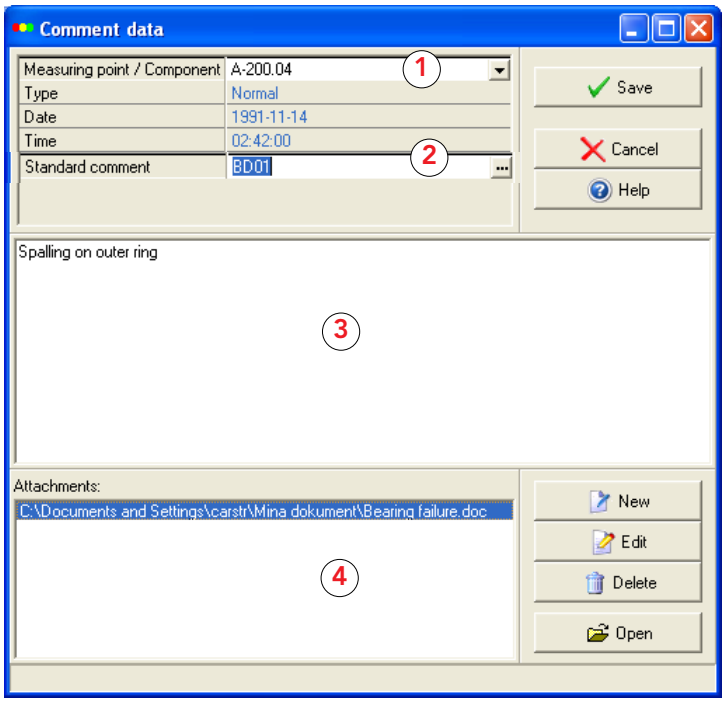

Comment data:

- Select measuring point or component number (1).
- Click "**...**" (2) to get the standard comment list.
- Add text (3) to the selected comment (option).
- Click **NEW** under **Attachments** to attach a hyperlinked document (4, optional).

Comment with additional text

An uploaded comment has the date and time when you set it on the data logger, and is always attached to a specific measuring point. When you add a comment in Graphic evaluation, you place it on the time scale and can attach it to either a measuring point or to the whole component. Your choice is made on the number line (1) of the component data form (drag the select arrow to open the number selection). A component comment is shown under each measuring technique diagram of all measuring points belonging to the component.

On the standard comment line (2) you can open the list of all standard comments (see previous page).

In the text field (3) you can enter a large amount of free text (optional).

Under **Attachments**, hyperlinked documents (4) can be added to the comment (optional).

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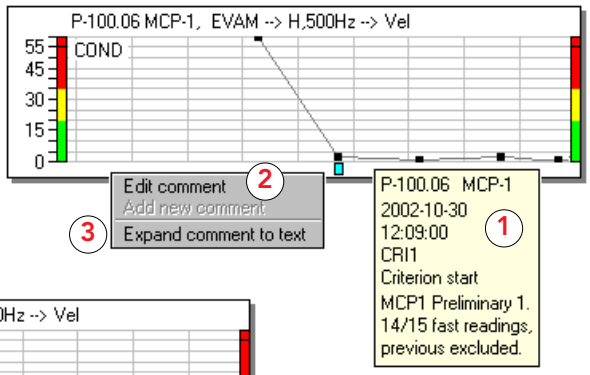
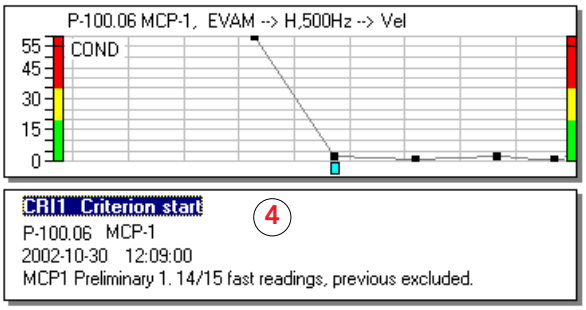
Display comment:

- Click on square to display comment (1)
- Right hand click to edit (2)





- Right hand click on square (3) to expand to text.
- Comment as text below the diagram (4.)

Comments in the Graphic Evaluation

Clicking on a comment square in the Graphic evaluation opens a hint with code, standard comment name and comment text (1). Right hand clicking opens a select window. You can edit the comment (2) or convert it into text (3). This text is placed beneath the diagram (4). It stays visible and is printed together with the diagram.

To delete a comment, right hand click anywhere inside the diagram field to get the **Show** window. Select **Comments**, mark the comment you want to remove, then click the recycle bin.

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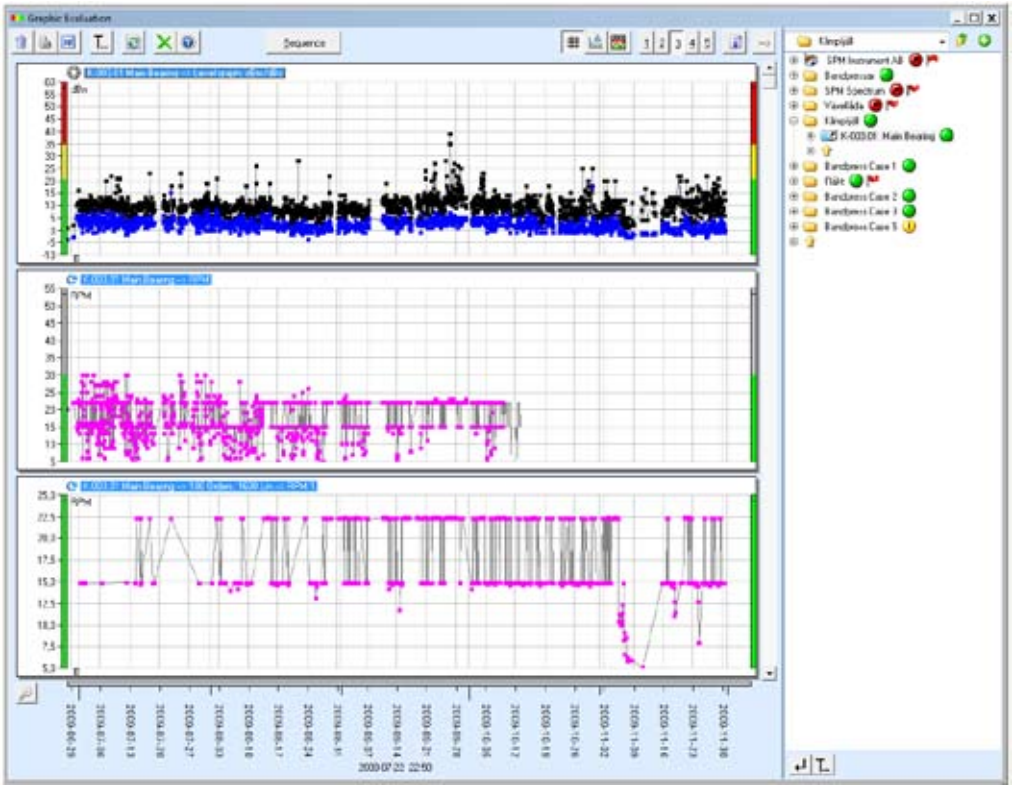

Graphic evaluation

Graphics functions in Condmaster Nova

The function Graphic Evaluation features e.g. the following:

- Close interaction between measuring point tree structure and the display of diagrams. Any item in the tree structure can be dragged to the graphics display.
- Extensive use of the right hand mouse button and key board commands to open sub functions and make direct jumps to registers, Lubmaster, spectrum display, etc.
- More options for mixing diagrams, tables with measuring result and comments plus texts in printed reports. Standard texts and logotypes can be stored.
- Storage of display sequences including texts and tables, as well as of individual screen layouts.
- The display of trend curves consisting of a running average of a user defined number of measuring results.
- The option of customizing the graphics display and printout by editing the drivers for screen and printer.

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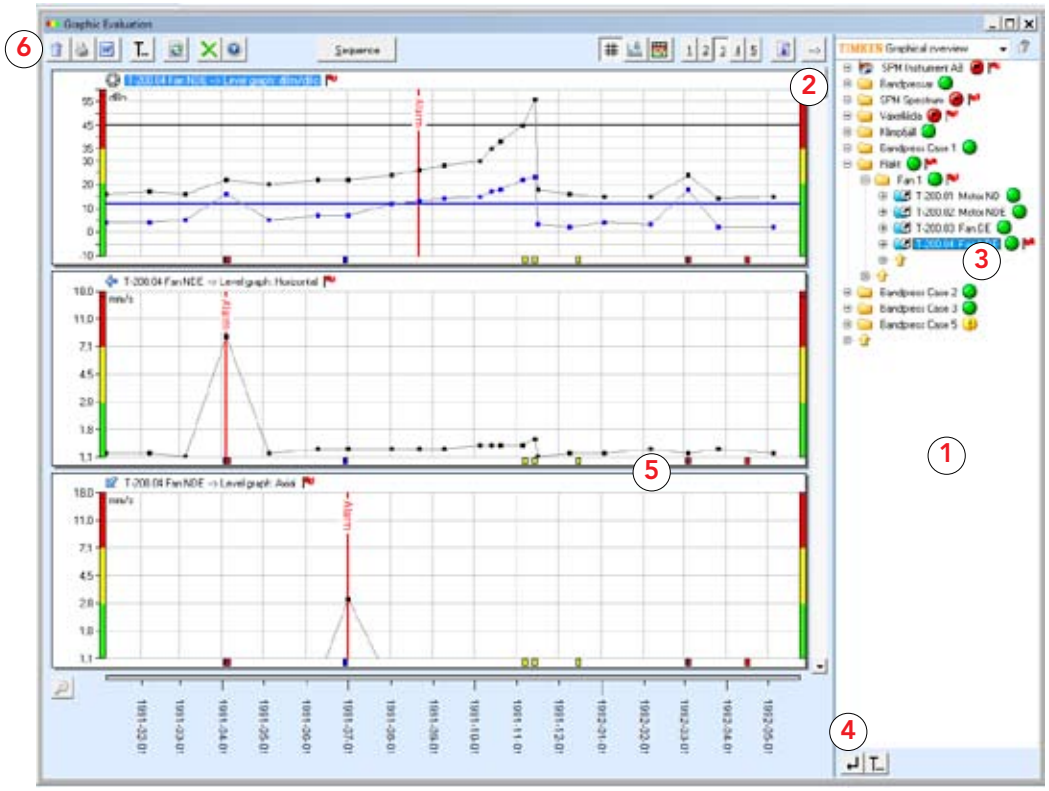

Display diagrams:

- Get the tree structure (1) with button (2).
- Click on a folder name (3), drag to the diagram window (5).

Selection of items for graphics display

Under **Maintenance** in the menu bar, select **Graphic evaluation**. The tree structure (1) is shown to the right of the graphics field. When jumping with a **Graphics** button from other places, the diagram(s) for the marked item are shown graphics field. To obtain the tree structure, click the button "<---" (2). Right hand clicking on the **Graphics** button in Graphical Overview takes you directly to **Load Sequence**.

To select items from the tree structure:

- Mark an item, grab its **name** and drag it to the graphics field. You can drag and drop folders, components, measuring points, or techniques (3).
- Press CTRL after marking the first to select several items on the same level from the same location (e. g. components from the same folder) in any order (SHIFT for consecutive order).
- Mark any item(s) at any level and use the button **Add diagrams** (4) to add after displayed graphs, or drag a marked item to the space (5) between two diagrams. Drop it when the cursor turns into an arrow.

Clear graphics field for a new selection:

- In the graphics field, mark all (CTRL+A), click on the **Recycle bin** (6). You can also use the DELETE key or drag marked items to the bin. When you load a sequence (see below), the graphics field is cleared automatically.

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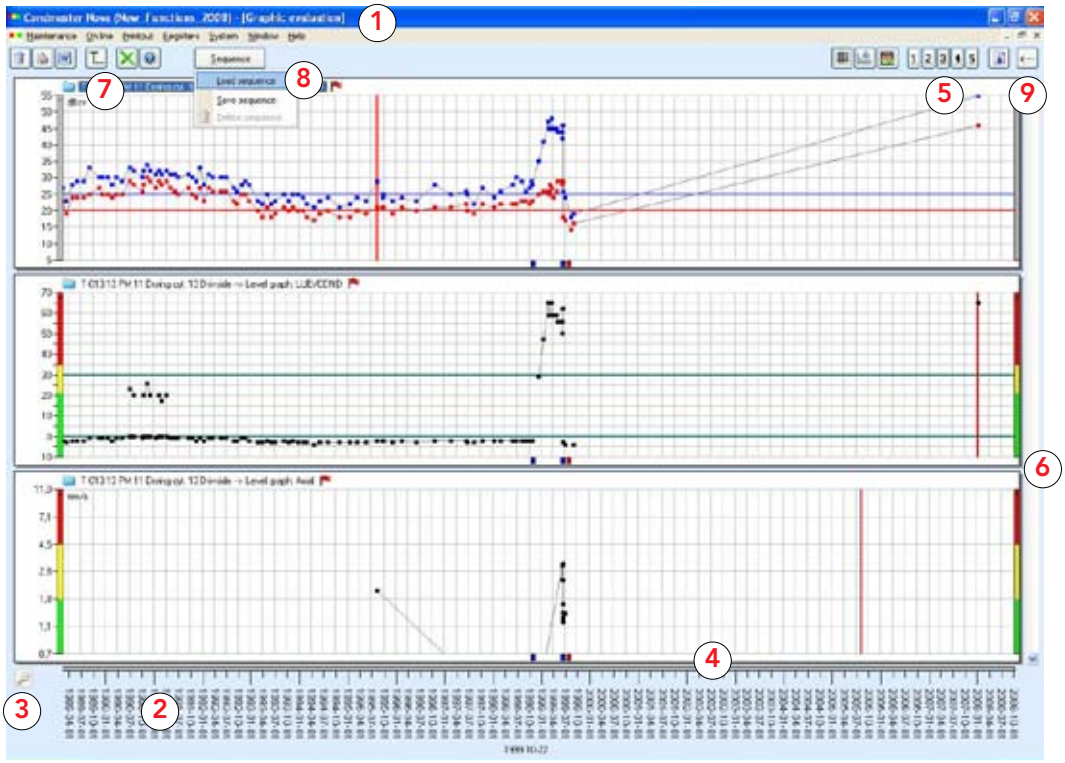

Change display of diagrams:

- Drag left to right on the time scale to zoom (2), zoom back with (3).
- Select number of diagrams (5). Press SEQUENCE (8) to change order.

The display of diagrams

The diagram title (1) consists of measuring point number and name plus measuring technique.

The time scale (2) is below the diagrams. The time intervals change with the length of the period shown. The horizontal date and time shows the time at the cursor position. To **zoom in** on a period, click on the time scale and drag from left to right. Use the magnifying glass (3) to zoom back. You can grab the time scale bar (4) and move the scale (and the diagrams with it) forward or backward in time.

The buttons 1 - 5 (5) are used to select the number of diagrams on the screen. A standard VGA screen (640*480 pixels) can only show 4 diagrams at a time. Use the scroll bar (6) to move up and down among the diagrams.

To move a diagram to a different position, grab the title (7) and drag it to the lower border of another diagram. Drop it beneath this diagram when the cursor changes to an arrow. If you hold down CTRL when marking the title, you move a copy of the diagram. The original remains in place.

Select sequence:

Use the button **Sequence** (8)) to select a saved sequence. To save a new sequence, drag items to the graphics field, select **Save sequence** and input a name. The sequence is saved in its present (edited) state.

The button "**--->**" ("**<---**") toggles the tree structure field off and on (9). You can use the keyboard keys PAGEUP, PAGEDOWN, HOME, and END to browse through the diagrams on the screen.

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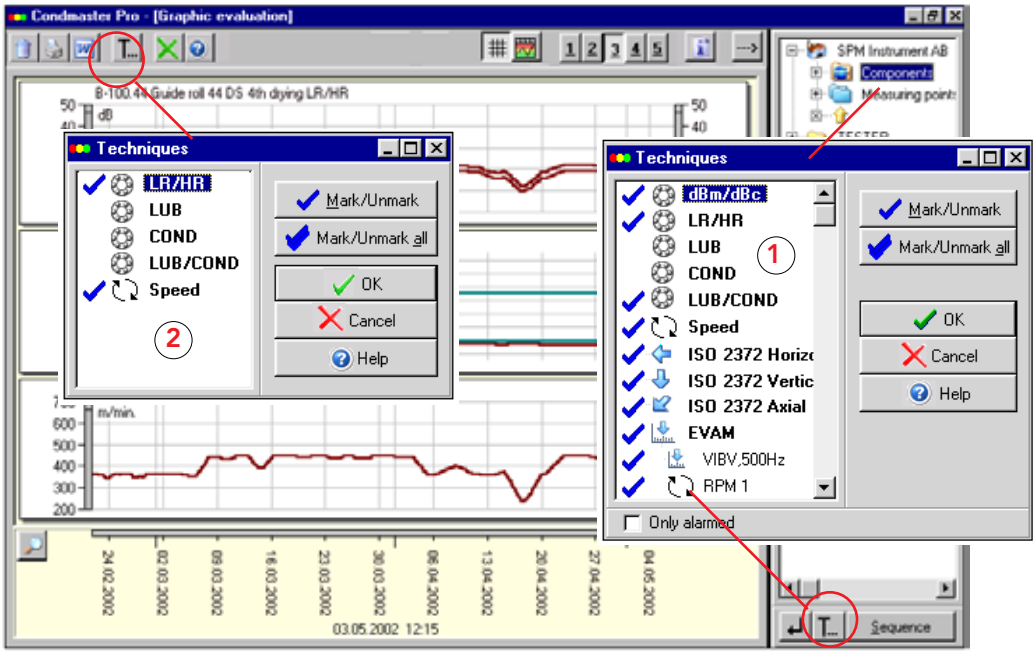

Select technique:

- Select the technique for the marked item in the tree structure (1).
- Select the technique for the displayed diagrams (2).

Selection of measuring techniques

The form for graphic evaluation contains two **SELECT TECHNIQUE** buttons. The button below the tree structure is connected with the marked item in the tree structure. It opens a form (1) showing all measuring techniques connected with the marked item. The form can be opened and edited before you drag the item to the graphics field. Right hand clicking on this technique button will automatically put the marked item into the graphics field after when you leave the technique selection form with **OK**.

Double clicking on a technique toggles the selection. The saved setting is used as default until changed.

Marking the box **Only alarmed** puts the diagrams of all measuring points on the alarm list (and in the marked part of the tree structure) into the graphics field.

LUB and COND can be presented in two different diagrams or within one diagram. For EVAM, you can deselect all assignments, condition parameters, and symptom parameters by deselecting EVAM. You can also deselect individual parameters. Condition parameters and symptoms are listed in alphabetical order. Symptom groups are listed as their individual symptoms.

The **Select technique** button above the graphics field opens a form (2) showing all measuring techniques connected with the displayed diagrams. The setting is not stored, unless you save the diagrams as a sequence.

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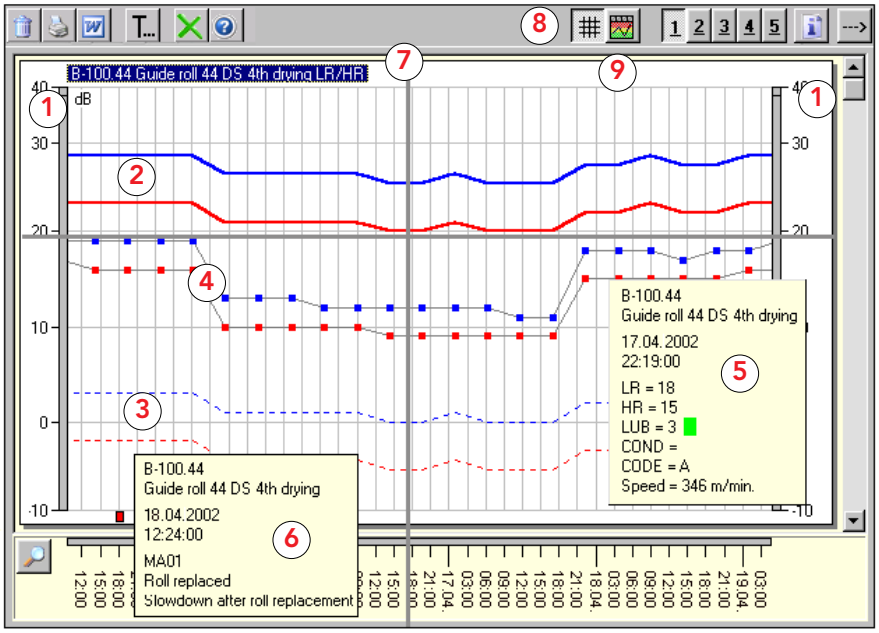

Elements of a diagram:

- Scales (1), alarm limits (2,3), measurements (4), grid on/off (8).
- Hints: results (5, click on point), comment (6, click on square).
- Jump to the measuring result register (8).

Elements of a diagram

The diagram on the screen expands to fill the available space. It has scales on the left and right hand sides (1). For evaluated measuring results, the scales are colored green - yellow - red. For raw values, like in this example, they are grey. When you grab either scale anywhere below the dividing line at the top, the cursor turns into a vertical double arrow and you can move the scale up or down (affects the active diagram plus its copies, if any). With the keyboard command CTRL+UP (DOWN) you can move the diagram to the right of the field (no values shown on right hand scale) while moving the left hand scale up and down.

Upper alarm limits (2) are shown as solid, lower alarm limits (3) as broken lines. In case of shock pulse readings with variable speed, the alarm limits for speed dependent values follow the machine speed, else the lines are straight.

Measuring results, here LR (blue) and HR (red), are represented as dots (4), connected by thin grey lines.

When you click on a measuring result dot, you get a box (5) showing measuring time and results. In an EVAM diagram, all EVAM results (even those shown in other diagrams) are displayed. In any other diagram, all other results (except EVAM) are displayed. Comments are shown as colored squares at the bottom of the diagram. Clicking on a square opens the comment box (6).

Moving the mouse while holding down the right hand button produces cross hairs (7). The **Grid** button (8) toggles the grid on/off. The **Measuring protocol** button (9) is active when a single measuring point is being displayed. It produces an even spacing between measuring results, independent of the time interval.

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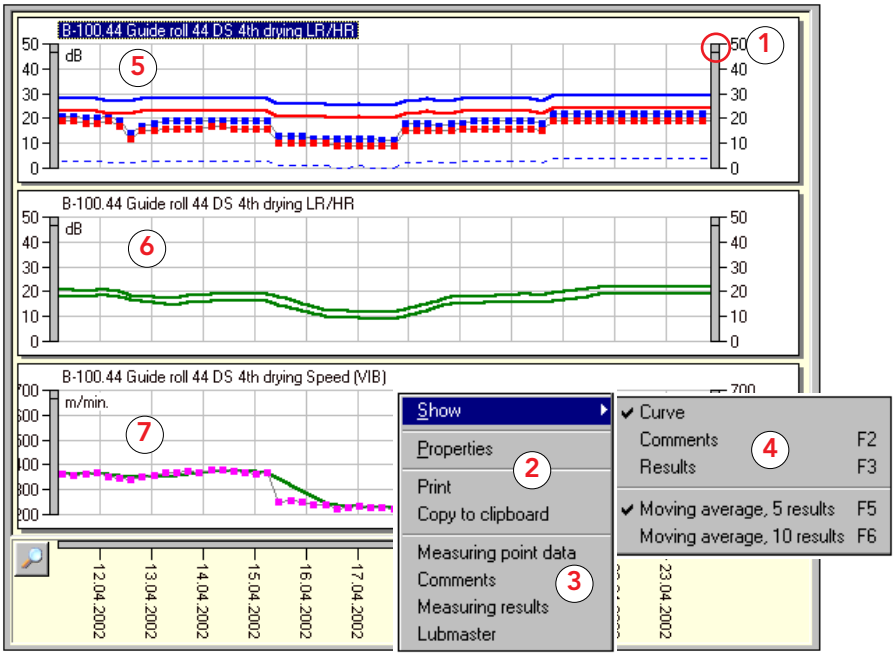

Moving average:

- Right hand click in a diagram for **Show** menu (2).
- Select **Show**, select **Curve** and/or **Average** (4).

Display of moving average

The top of either scale (1) can be grabbed. The cursor turns into a horizontal double arrow and you can expend or reduce the diagrams sideways within the diagram field (affects the whole display and is saved). After using CTRL+UP (DOWN), you can restore the values on the right hand scale by dragging this scale to the left.

Clicking with the right hand mouse button (without moving the mouse) anywhere in a diagram produces a menu (2), allowing you to print the active diagram or copy it to the clipboard. Its lower part (3) contains jumps to the functions **Measuring point data**, **Comments**, **Measuring results** (all points), **Lubmaster** (SPM LR/HR points), **Compare spectrum** and **Waterfall diagram** (EVAM points), each for the active diagram.

Select **Show** to obtain a menu (4) that allows you to manipulate the active diagram.

The upper diagram (5) shows the measuring results as CURVE (**Curve** is marked on this menu, everything else is off). When you unmark **Curve** as well, you get no diagram. The middle diagram (6) is a copy of the one above. **Curve** is off and **Moving average, 5 results** is on.

The lower diagram (7) is obtained by activating both **Curve** and **Moving average, 5 results**. You can produce the same effect with only **Curve** on by pressing **F5** (for 5 results average) or **F6** (for 10 results average). This toggles the average display on and off, for all marked diagrams. Settings made under **Show** can be saved with a sequence.

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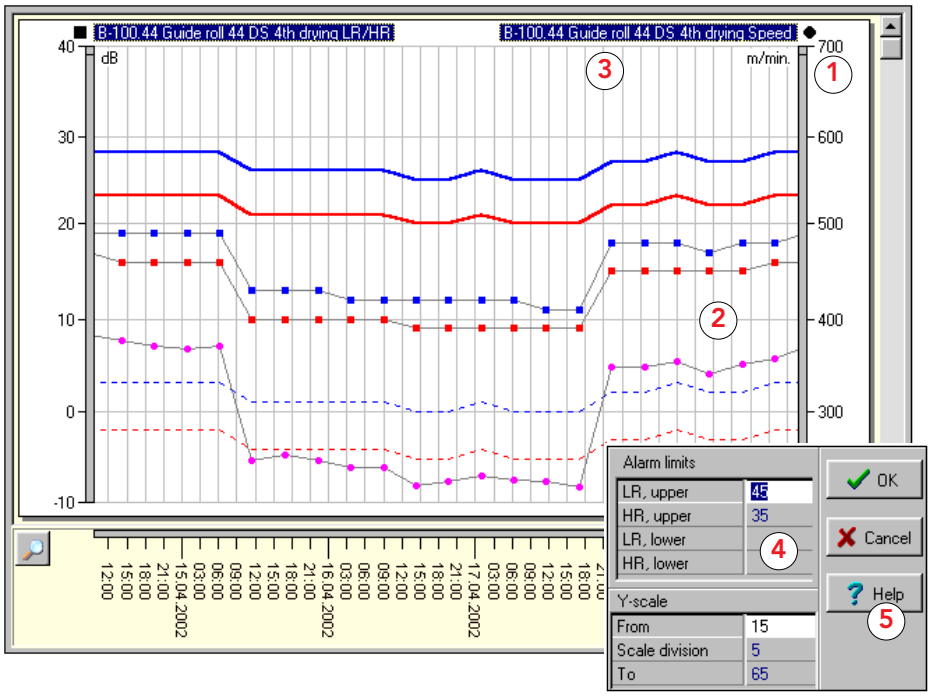

Combine diagrams, edit limits, scale:

- Grab the diagram title, move to the right hand scale (2) of another diagram.
- To change alarm limits (4), scale (5): open **Show**, select **Properties**.

Combining two diagrams

To place a diagram inside another diagram, you grab its title and drag it to the right hand scale of the other diagram (1). Drop it when the cursor turns into an arrow. The moved graph is superimposed on the other (2). If you hold down CTRL while grabbing the diagram, you move a copy.

The title of the moved diagram (3) is written against the right hand scale, which shows the values of the moved diagram.

To extract the moved diagram, grab its title and drag it to any space above, below, or between the other diagrams. Drop it when the cursor turns into an arrow.

To obtain the **Show** menu (which is always linked to a specific diagram), you have to click on either the title or the scale of the diagram you want it for. **Properties** on the **Show** menu allows you to change alarm levels (4) and the scale properties (5) in the measuring point register.

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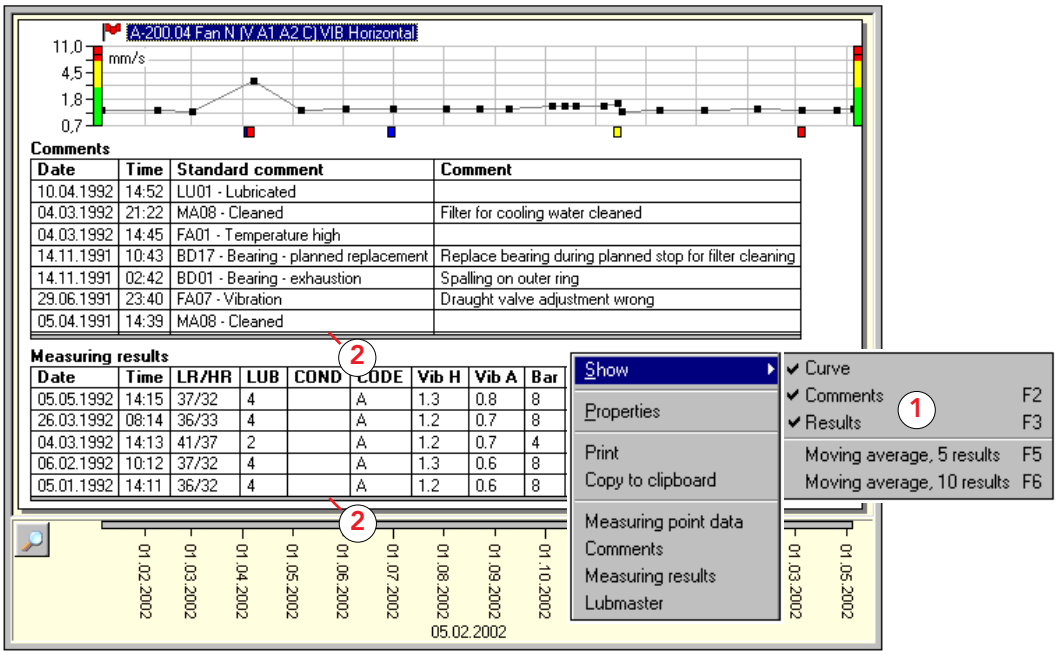
A-200.04 Fan N (V A1 A2 C) VIB Horizontal
11,0
4,5
1,8
0,7
mm/s
Comments
Date | Time | Standard comment | Comment
10.04.1992 | 14:52 | LU01 - Lubricated
04.03.1992 | 21:22 | MA08 - Cleaned | Filter for cooling water cleaned
04.03.1992 | 14:45 | FA01 - Temperature high
14.11.1991 | 10:43 | BD17 - Bearing - planned replacement | Replace bearing during planned stop for filter cleaning
14.11.1991 | 02:42 | BD01 - Bearing - exhaustion | Spalling on outer ring
29.06.1991 | 23:40 | FA07 - Vibration | Draught valve adjustment wrong
05.04.1991 | 14:39 | MA08 - Cleaned
Measuring results
Date | Time | LR/HR | LUB | COND | CODE | Vib H | Vib A | Bar
05.05.1992 | 14:15 | 37/32 | 4 | A | 1.3 | 0.8 | 8
26.03.1992 | 08:14 | 36/33 | 4 | A | 1.2 | 0.7 | 8
04.03.1992 | 14:13 | 41/37 | 2 | A | 1.2 | 0.7 | 4
06.02.1992 | 10:12 | 37/32 | 4 | A | 1.3 | 0.6 | 8
05.01.1992 | 14:11 | 36/32 | 4 | A | 1.2 | 0.6 | 8
2
2
Show
Properties
Print
Copy to clipboard
Measuring point data
Comments
Measuring results
Lubmaster
Curve
Comments F2
Results F3
1
Moving average, 5 results F5
Moving average, 10 results F6
01.02.2002
01.03.2002
01.04.2002
01.05.2002
01.06.2002
01.07.2002
01.08.2002
01.09.2002
01.10.2002
01.03.2002
01.05.2002
05.02.2002

Comment and measuring result tables:

- Activate **Comments** and **Results** (1) under the **Show** menu.
- Extended/shorten tables by grabbing their lower borders (2).

Comment and measuring result tables

On the **Show** menu, you can also activate **Comments** and/or **Results** (1).

Both comments and measuring results are listed for the displayed time span, starting with the latest reading/ comment shown on the left hand side of the diagram.

The lists can be extended/shortened by grabbing its lower border (2) and pulling downwards/upwards when the cursor turns into a double vertical arrow.

For EVAM diagrams, the result list shows EVAM parameters only. For all other measuring techniques, it shows all results except EVAM parameters.

When only **Curve** is marked, the **Comments** table can be toggled on/off with **F2**, the **Results** table with **F3**. This is valid for all marked diagrams.

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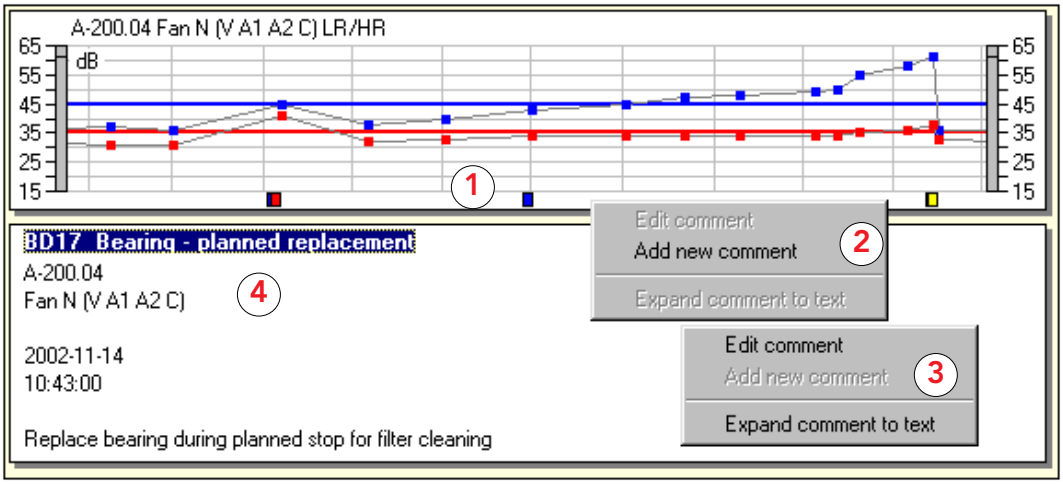

Edit / add comments:

- Right hand click on the comment line below the diagram (1).
- Click **Add new comment**, select a standard comment (2), add text.
- Right hand click on an existing comment to edit or convert to text (3).
- Comment text is displayed beneath the diagram (4).

Editing and adding comments

A right hand click on the space where the colored squares representing comments are placed (1) allows a jump to the comment register where you can add a new comment (2).

A right hand click on a colored square gives you two options (3): you can edit the active comment in the register, or you can convert it into a text (4) that appears beneath the diagram.

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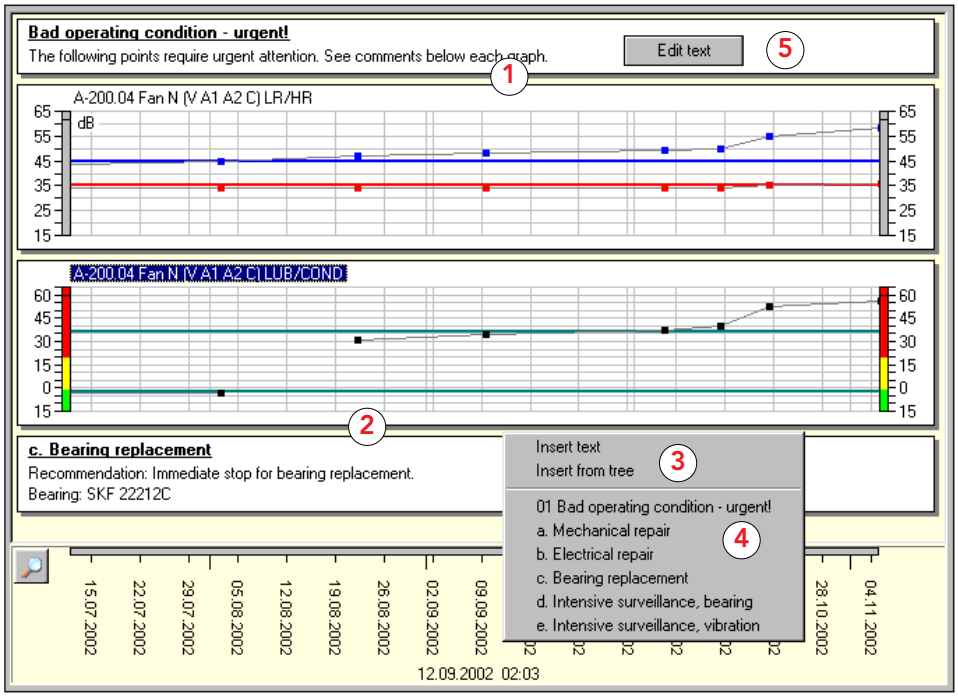

Text with a diagram:

- Right hand click on the space above (1) or below (2) the diagram to obtain the **Insert text** menu. Go to **Insert text** (3) or select a standard text (4).

Text above and below a diagram

A right hand click on the space immediately above (1) or below (2) a diagram opens the **Insert text** menu (3).

You can then select **Insert text** to go to the text menu (see next page) or, in case you have a store of standard texts, select one of these. The text is inserted in cursor position.

A right hand click on the text opens **Edit** (5), which leads to the text menu where you can make changes.

Texts can be saved as part of a sequence.

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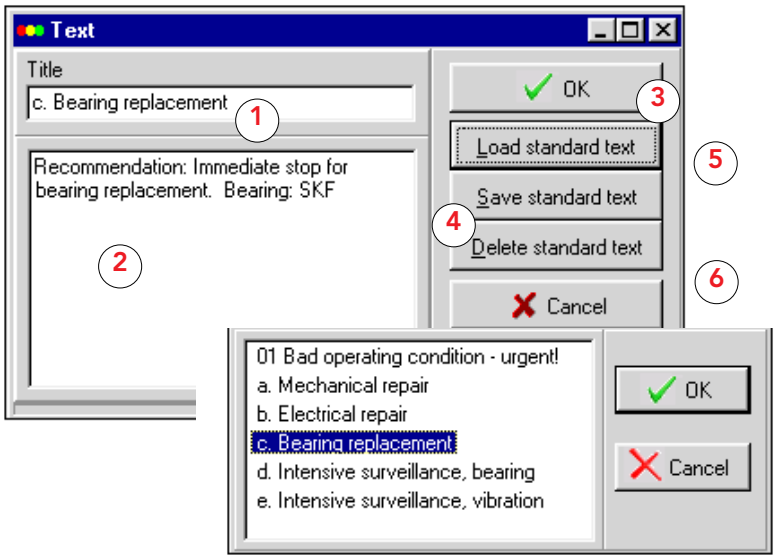

Standard text:

- Input a title (1) and, as an option, text (2).
- Save as standard text (4).

Saving standard texts

The text for a diagram must have a title (1) and can have a body (2) in the field below.

When you finish with **OK** (3) only, the text appears in the graph but is not saved elsewhere. Before clicking **OK**, you can click **SAVE STANDARD TEXT** (4). This saves your text for further use and puts its title on the list of standard texts. The list is sorted alphabetically.

Standard texts are recalled with the button **LOAD STANDARD TEXTS** (5). When on the screen, they can be deleted (6). When you edit the title of a standard text (without clicking **DELETE**), you create a new text.

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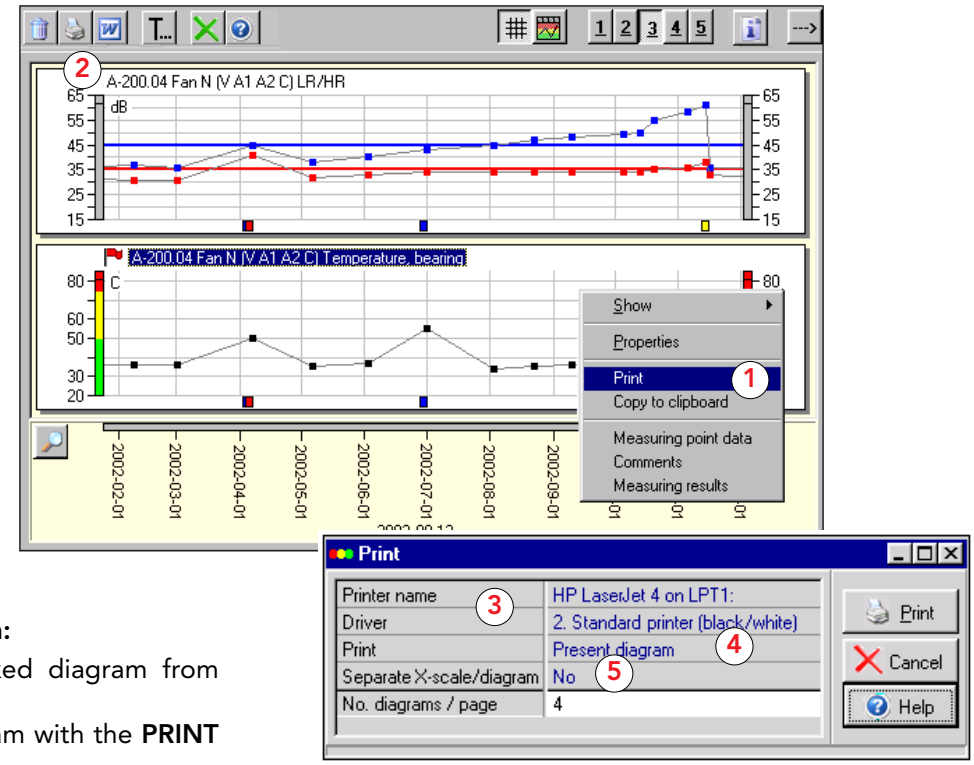

Print diagram:

- Print marked diagram from **Show** (1).
- Any diagram with the **PRINT** button (2).

Printing diagrams

There are two alternative ways of ordering a printout. On the **Show** menu, you can select **Print** to print the active diagram (1).

To print several or all diagrams, you can drag them to the printer icon (2) or click on the printer icon.

The **Print** menu allows you to select a connected printer and also shows the active printer driver (3). Clicking on a line opens a selection. You can print all diagrams, selected diagrams, or the active diagram (4).

The choice **X-scale with each diagram Yes/No** (5) has the following effect: **Yes** means that the time scale is printed below each individual diagram. **No** means that the time scale is printed once at the bottom of each page.

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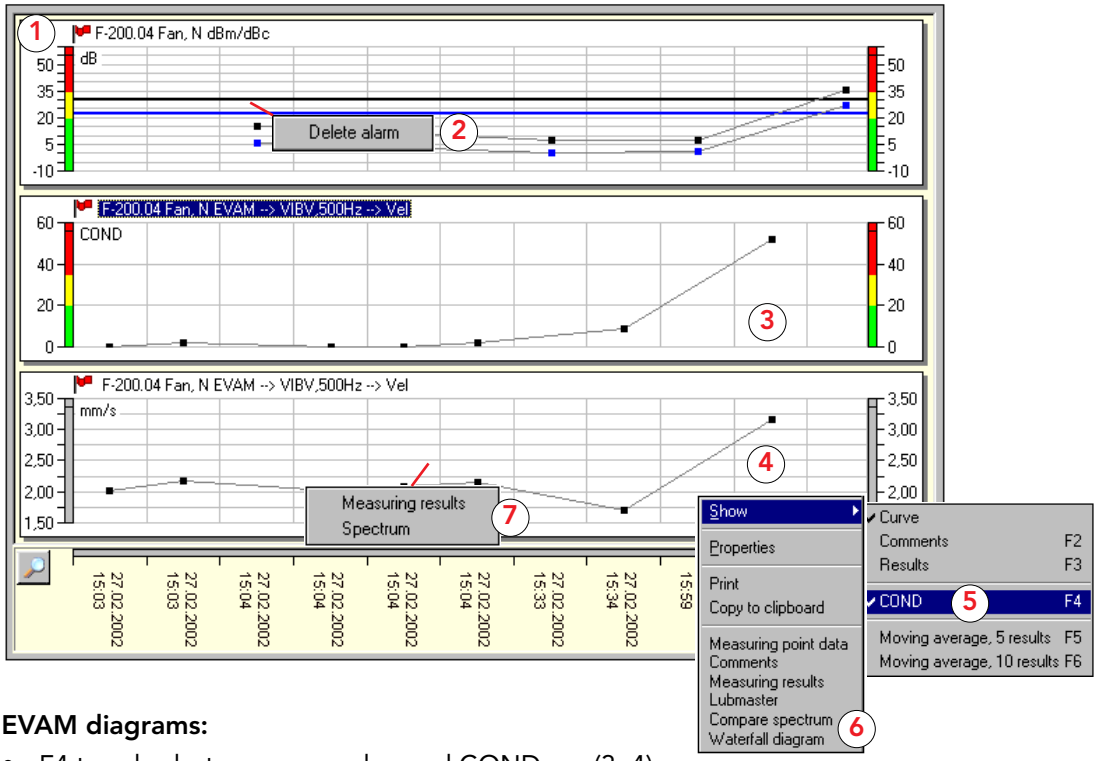

EVAM diagrams:

- F4 toggles between raw value and COND no. (3, 4).
- Right hand click for **Show** and jumps.

Popup menus for EVAM points and alarm

Diagrams for measuring techniques on the alarm list have an alarm flag in front of the title (1). A left hand click on the flag gives a jump to the alarm list. A right hand click opens the function **Delete alarm** (2).

For EVAM measuring points with COND number calculation, the **Show** menu allows you to display an EVAM parameter as its COND no. diagram (3) with colored scales, or as a diagram of the raw values (4). The third diagram in this example is a copy of the second. For the second diagram, COND on the **Show** menu is marked (5), for the third it is not marked. If COND is not marked, you can toggle it on/off with F4, for all marked diagrams.

For EVAM techniques, there are direct jumps to **Compare spectrum** and to **Waterfall diagram**.

A right hand click on an EVAM result allows a direct jump to **Spectrum**.

Please note: When you open Graphic evaluation, Condmaster Nova reads all measuring results, then calculates all EVAM parameters, which can take a noticeable time. However, the selected measuring points have preference and are displayed as soon as their data are ready. An immobile alarm flag shows that the processor is still busy with calculations, which causes small delays in screen updates. A moving alarm flag shows that the calculations are finished.

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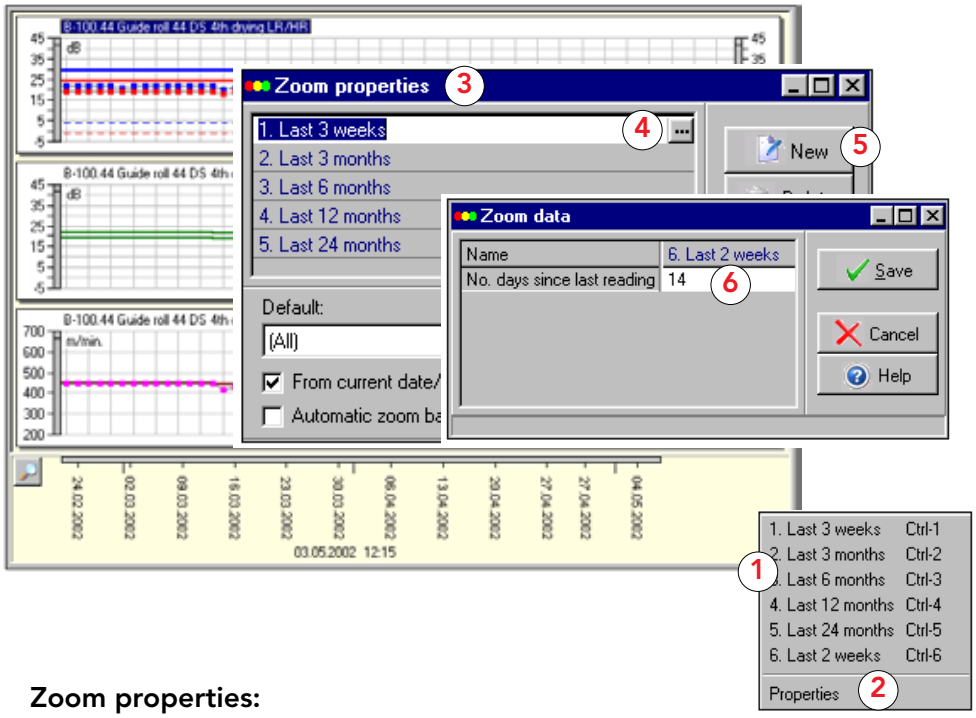

Zoom properties:

- Right hand click on the time scale to select (1).
- Use **Properties** (2) to edit.

Zoom Properties

Right hand clicking on the time scale produces a list of available zoom scales (1). These can also be activated by pressing CTRL+1 to max. CTRL+9. You can have more than 9 zoom scales, but the additional scales can only be selected by marking them on the drop-down list.

To edit zoom scales, select **Properties** (2). This opens the **Zoom proerties** menu (3). To edit, click "..." (4) for an item on the list. With the button **NEW** (5) you can add items.

A zoom scale is defined by a name and a time interval in days (6). Any of the zoom scales can be used as the default setting for the standard zoom when you open diagrams.

From current time and backwards means that the time scale starts with the present date and time, else it starts with the date and time of the most recent measuring result.

To provide a fast graphics display, Condmaster Nova starts showing diagrams after approx. two seconds. The program then gets the remaining measuring results, if any, and adds more diagrams until all selected diagrams are available. This can affect the zoom range in case results read later in the process span over a longer time. When **Automatic zoom range extension** is on, the zoom range is automatically adjusted to accommodate all measuring results, i. e. you can click on the magnifying glass to extend the range presently shown. Data arriving from a CMS or VCM unit after the start of the graphics function are not included in the graphics display.

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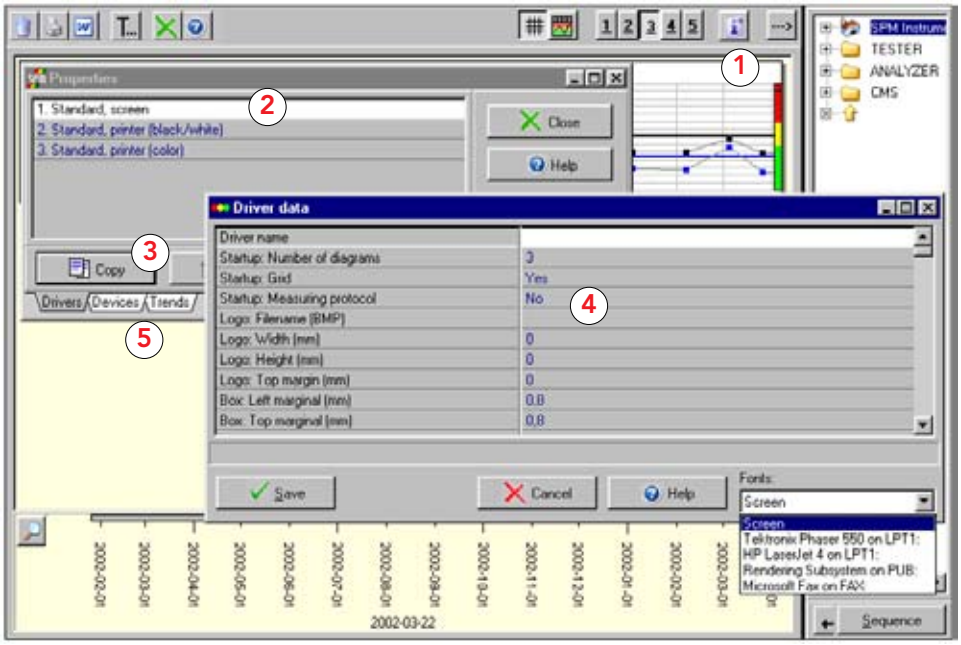

Drivers for screen and printers:

- Click "**i**" (1) for the driver menu (2).
- Click **COPY** (3) to edit the driver data (4).

Drivers for screen and printer

The button "**i**" above the graphics field (1) opens a **Properties** window with three functions:

- Modification of the drivers for screen and printers
- Selection of the drivers for screen and printers
- Creation of a new running average curve.

The function selection is made by clicking on one of the tabs (5).

Marking a driver (2) and clicking the button **COPY** (3) opens the driver data (4). Modifications are saved under a new driver name. The new driver can the be linked with the screen or a printer, see next page.

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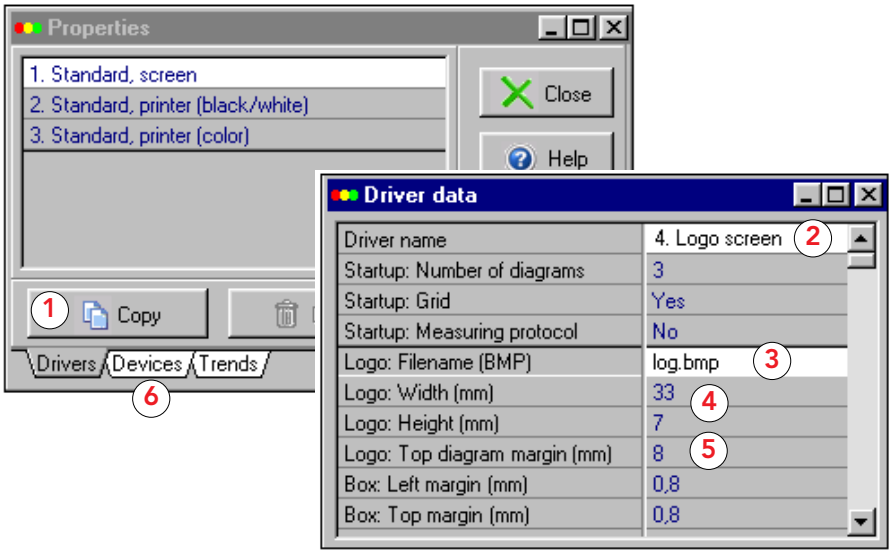

New driver:

- Mark a standard driver and click **COPY** (1). Name (2), edit the driver data.
- Select **Devices** (6) to save and activate.

Logotype on screen and printouts

One example of modified drivers is the display and printout of a company logotype together with diagrams. For this, you must first make a copy of the standard driver. Mark e. g. **1 Standard screen** and click the **COPY** button (1).

On the driver data menu, input the name of the new driver (2), e. g. **5 Logo screen**. When the logotype is in the Condmaster Nova directory (in bmp format), you input the file name (3), else you input path and file name.

Next, you define the width and height (4) of the logotype as shown on the screen, keeping the proportions of the picture. You can use 1 decimal.

Margin, top diagram (5) must be set to a value greater than the height of the logotype, else the top diagram will cover part of the logotype.

The modified driver is saved and selected as the screen driver under **Devices** (6), see next page. To get the logotype on the printouts, you have to repeat this procedure for one or more of the printer drivers.

Driver copies can be opened for editing by double clicking on their names.

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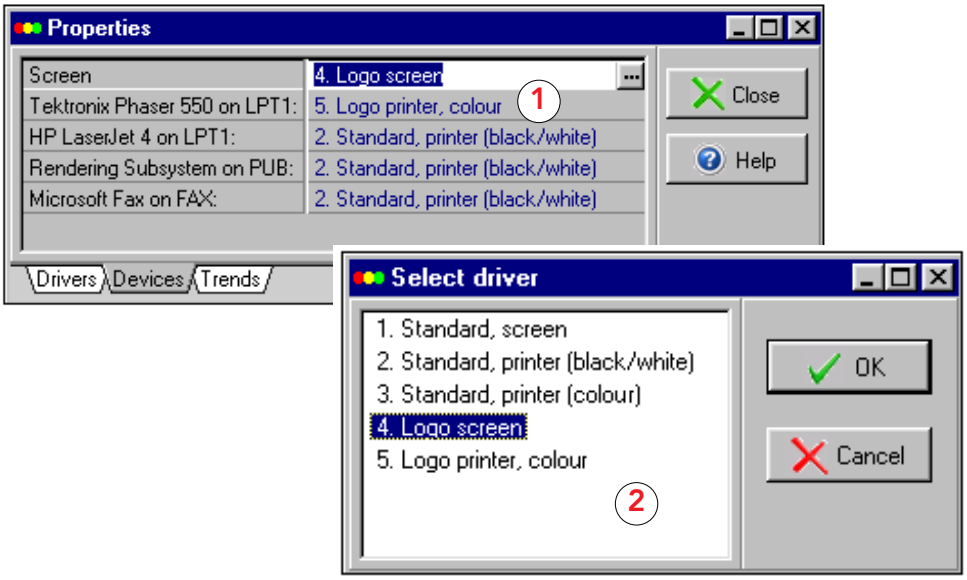

Select driver:

- Click on "**...**" for the active driver (1) on the **Properties** menu.
- Select a driver from the list (2), click **OK**.

Connecting drivers with screen and printers

The program contains three standard drivers, for the screen, a black and white printer, and a color printer. In addition, you can save your own modified versions (see previous page).

The **Properties** menu lists the display and printers connected to your PC or work station and their active drivers. To select a different driver, click on "**...**" (1), mark it on the list (2) and click **OK**.

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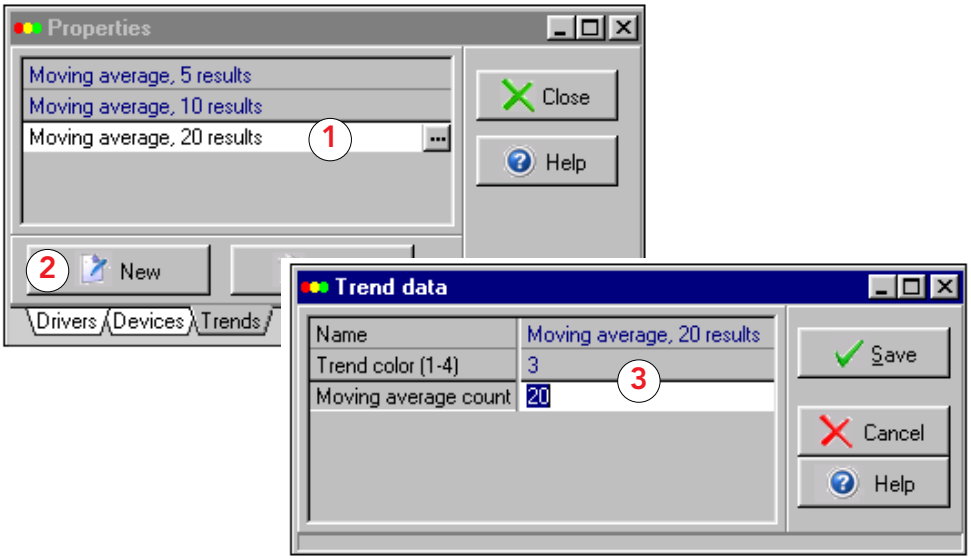

Moving average:

- Click on the name (1) to edit, or **NEW** (2) to create.
- Input / edit name and count (3).

Creating new moving average

The selection **Trends** under the **Properties** menu allows you to create the kind of trend curve you want to use for your diagrams.

To edit an existing header, click on "**...**" (1). To create a new trend curve, click on the **NEW** button.

In both cases, you open the trend data window where you input a name, select a color, and input the number of results (3) for the moving average calculation (min. 2, max. 99).

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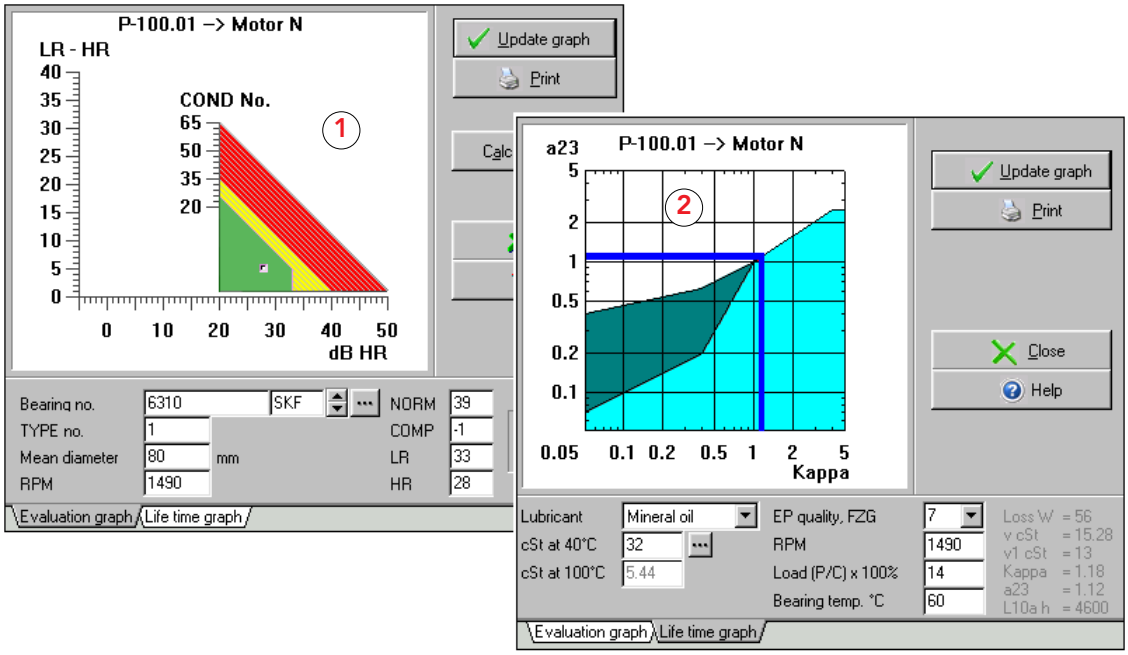

LUBMASTER function:

- Evaluation graph (1) for bearing condition.
- Life time graph (2) for optimizing the lubricant.

Lubmaster

LUBMASTER is based on three sources:

1 Timken's algorithms for bearing condition evaluation, using the LR/HR method.

2 The formulas recommended by ISO 281 for rating life calculation.

3 The formulas used by lubricant and bearing manufacturers to calculate life adjustment factors which quantify the effect of lubricant type, viscosity, load, and temperature on bearing life.

LUBMASTER works with the Condmaster Nova bearing catalogue data (bearing type, size, and load rating) for bearings with standardized dimensions according to ISO 15, ISO 355, and ISO 104. Specifically, LUBMASTER can be used for:

1 Training - the graphic display of the Timken evaluation graph clearly shows the relationship of shock values and condition codes.

2 Calibrating Timken measuring points - by comparing calculated LR/HR values with the measured results, one can determine a calibration constant (COMP no.) for each individual bearing application.

3 Assessing alarm limits - the display shows the dynamic range of LR/HR readings, LUB and COND numbers.

4 Optimizing lubrication conditions - by changing lubrication data (e.g. lubricant type, viscosity), one can simulate the effect such changes would have on bearing life expectancy.

For this, you have two LUBMASTER functions, the evaluation graph (1) and the life time graph (2).

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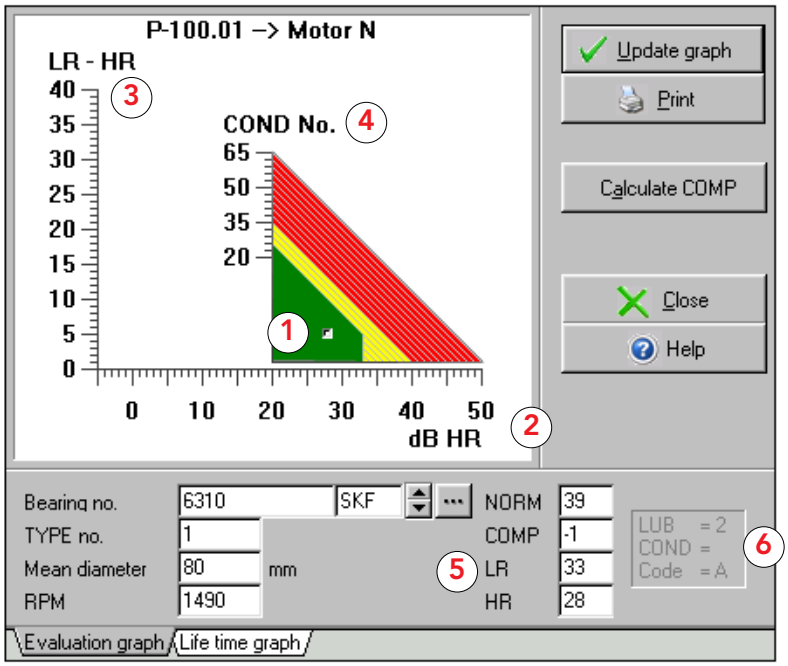

LUBMASTER Evaluation graph:

- Bearing data and graphical display of evaluation results.

The evaluation graph

The evaluation graph shows the green-yellow-red condition zones and the bearing symbol (1). The shape of the graph and its position relative the HR scale (2) varies with bearing type, size, and rpm. In a correct shock pulse reading, the LR value is always higher then the HR value. The difference between LR and HR is called delta, shown on the vertical scale (3). The COND no. scale (4) is constant, 20 to 65.

The bearing symbol can be moved with the cursor. The LR/HR values (5) corresponding to its position will be shown, as well as the resulting condition codes (6). The colored fields of the graph and the corresponding CODE nos. represent:

CODE A	Good condition (green)
CODE B	Dry running (yellow, low delta)
CODE C	Caution - beginning damage (yellow, high delta)
CODE D	Bearing damage

With CODE A and B, the condition data field contains a LUB no. describing lubrication condition. With CODE B, C, and D you get a COND no. indicating the degree of surface stress and damage. These CODES are valid provided the signal comes from the bearing and not from a disturbance source in the machine.

When the bearing symbol is moved below the evaluation graph (HR larger than LR), you get error code E2 = "Disturbance". This means that such a reading cannot originate from a rolling element bearing.

When the bearing symbol is moved to the left of the evaluation graph, you get the error code E3 = "Signal too low".

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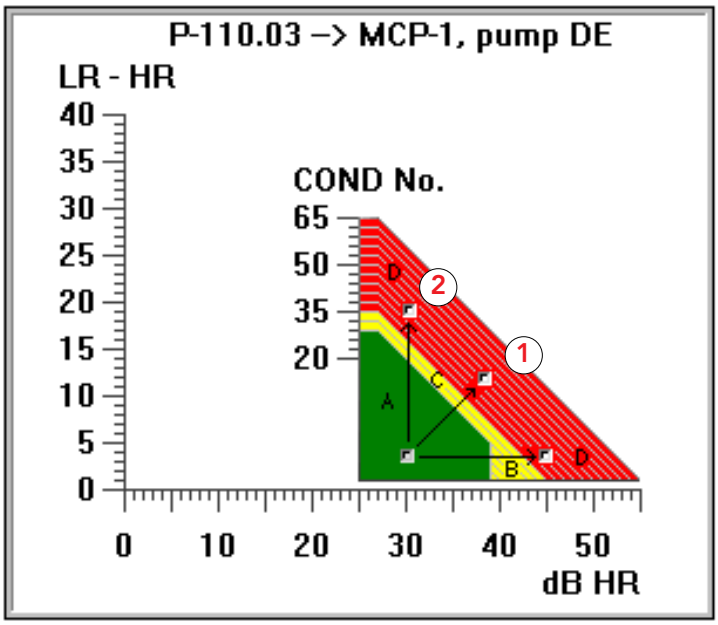

LUBMASTER Evaluation graph:

- Bearing condition development from good to bad.

Bearing condition development

Bad bearing condition can be caused by poor lubrication. When the bearing is running dry, the overall shock pulse value increases while the delta value (the difference between LR and HR) stays low (1).

The LUB no. indicates the thickness of the oil film in the rolling interface. LUB no. = 0 means dry running condition. The interpretation of LUB nos. between 1 and 4 depends on the bearing type. For ball bearings, 1 to 2 means “boundary lubrication” and higher values “full lubrication”. For roller bearings, 1 to 4 means “boundary lubrication” and values above 4 “full lubrication”. Dry running eventually leads to surface damage, so the CODE changes from A to B to D.

Surface damage normally causes a high delta value (2), and the CODE changes from A to C to D. The COND no. (condidition number) indicates the degree of surface stress and damage in the rolling interface and should be interpreted as follows:

COND no. below 30	minor damage
COND no. 30 to 40	increasing damage
COND no. above 40	severe damage

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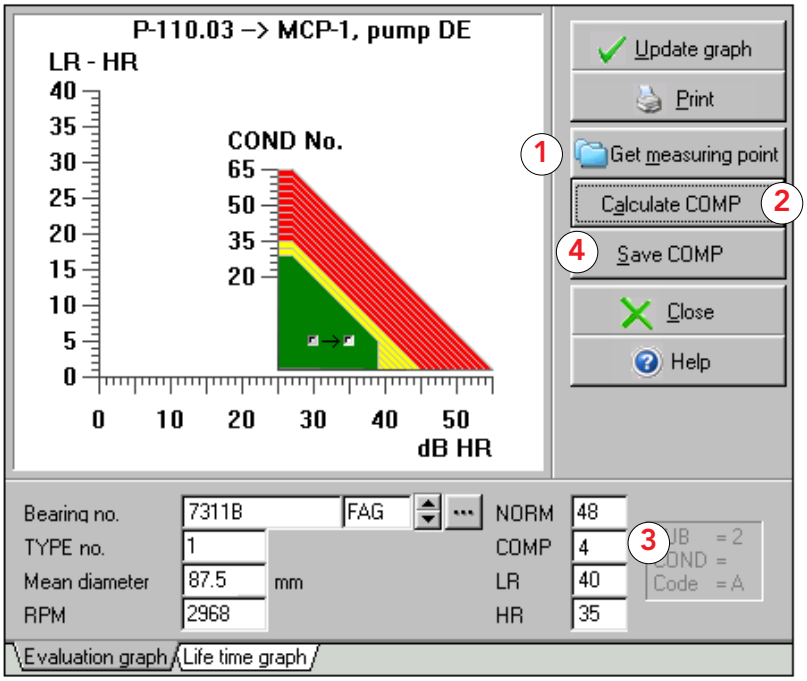

COMP no. calculation:

- Click **GET MEASURING POINT** (1) and **CALCULATE COMP** (2).
- The COMP no. (3) is displayed. Click **SAVE COMP** (4).

Measuring point calibration

To get an accurate evaluation of LR/HR readings, it is often necessary to calibrate the measuring point. Get a shock pulse reading from the measuring point. Make sure that it is accurate and that there is no disturbance. Save the reading in Condmaster Nova and open LUBMASTER. When jumping from the Graphical Overview, you automatically get the data for the marked measuring point, including the latest measuring result. Else, click **GET MEASURING POINT** (1) and select the point. A good bearing should be in the centre of the green field, or slightly right of the centre.

Go to the **Lifetime graph** and input the lubrication data. This is not absolutely necessary but improves accuracy, see next page. Click **UPDATE GRAPH** and **CALCULATE COMP** (2). This displays the COMP no. (3) and moves the bearing symbol unless COMP = 0. Accept *positive* COMP nos. by clicking **SAVE COMP** (4). The COMP no. is now part of the basic bearing data and will be added to each reading before it is evaluated.

Setting a COMP no. does not affect the measured LR/HR values or the dynamic range of the shock pulse measurement. If bearing condition deteriorates, you get the same increase in the LR/HR values with or without COMP no. The COMP no. simply helps you to avoid misleading error and condition codes and makes it easier to follow bearing condition development.

Warning: Avoid using negative COMP nos. unless you know exactly what you are doing! For bearings with high but stable readings, it is better to increase alarm levels than using negative COMP nos.

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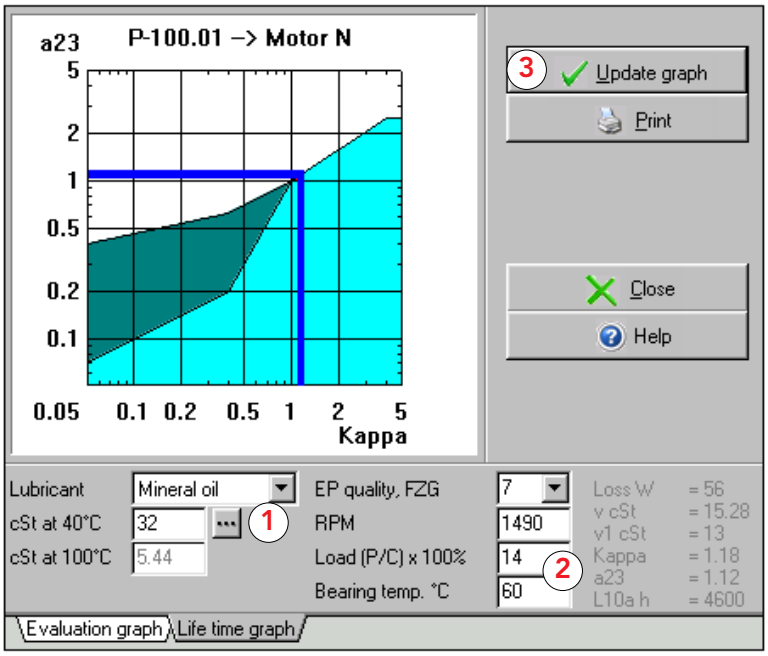

Life time graph:

- Select lubricant, viscosity (1). Set **FZG** to 12 (HP additives) or to 7 (none). Enter load ratio (10%), bearing housing temperature (2). Click **UPDATE** (3).

Lubrication data for COMP no. calculation

As a rule, you should calibrate after entering the lubrication data. You can do that when you create the measuring point. You can use an approximate value for bearing load (≈10%), but the lubricant data (1) and the bearing temperature (2), measured on the bearing housing under normal operating conditions, should be accurate.

However, it is possible to obtain a COMP no. without entering lubrication data. LUBMASTER will then give you a COMP no. based on the calculated HR value corresponding to Kappa = 1 (full lubrication). The COMP no. thus received is "reasonably accurate" in the low speed range but tends to be too high for bearings in the higher speed range, where you can expect Kappa values considerably greater than 1.

As a guide: Bearings in the low speed ranges, up to 500 rpm, tend to have Kappa values near or below 1, even when they are properly lubricated. The speed is too low to build up an oil film which can separate rolling elements and raceway. In the medium speed range, 500 to 3000 rpm, you can expect Kappa values above 1 with the right lubricant viscosity. In the high speed range, above 3000 rpm, oil film thickness can drop again because the lubricant cannot flow back as fast as it is pressed aside by the rolling elements, and also because higher temperature reduces oil viscosity.

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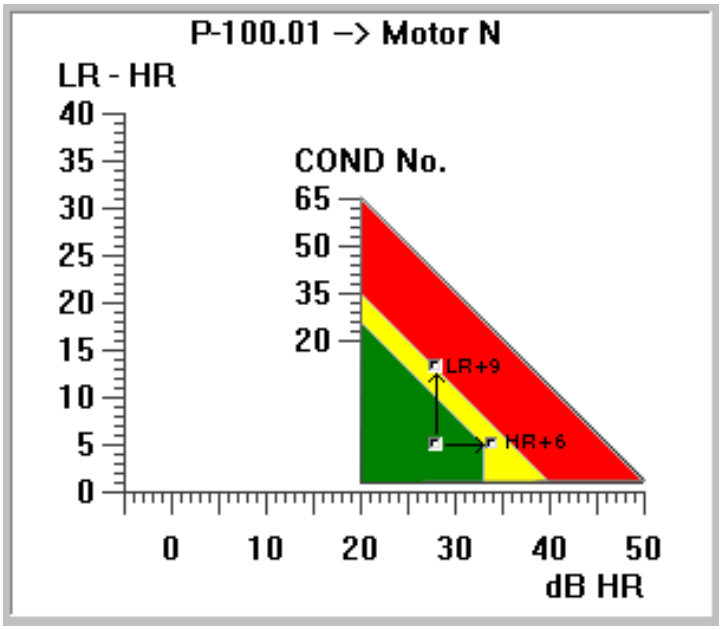

Alarm limits:

- From the position where COMP = 0, go right (up) and note the difference in LR/HR. Normal LR range good to bad = 8-9 dB.

Calculation of alarm limits

In the measuring point register, you can program alarm limits for COND, LUB, LR and HR. With LUBMASTER, you can easily find suitable limit values. Again, the results will be more accurate if you input lubrication data (bearing load is not important in this context).

To find suitable alarm limits for HR and LR, move the bearing symbol into a position where **CALCULATE COMP** returns COMP no. = 0. Set LR = HR+4. The bearing symbol is now in the exact "Good condition" position according to Timken evaluation rules. If you move the bearing symbol straight up until it touches the red condition zone, the displayed LR value is a suitable LR alarm limit.

Normally you receive COND no. 29 when passing the limit from CODE A to CODE C. This is a suitable alarm value for a COND no. alarm, giving a first warning of developing bearing damage. You can use the LR value received on entering the red zone as a second damage alarm.

Go back to the initial position, then straight to the right. The LUB no. will decrease as you come closer to the yellow condition zone. Pick a suitable value for "poor lubrication" alarm, e.g. half the value of the original LUB no.

You can use the HR value shown when CODE B comes up as limit for a "dry running" alarm.

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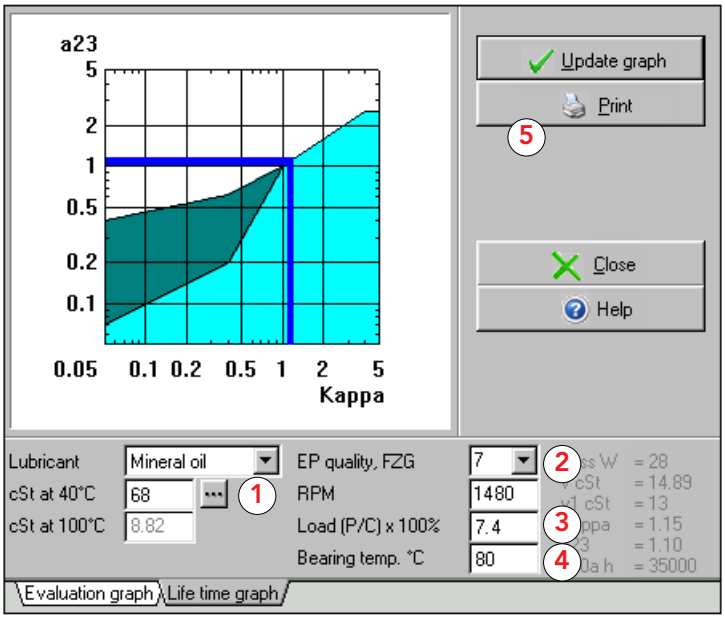

Life time graph:

- Input lubricant data (1, 2), load ratio in % (3), bearing housing temperature (4). Click **UPDATE GRAPH** (5).

The lifetime graph

The lifetime graph shows the relationship between the Kappa value (horizontal scale) and the bearing life adjustment factor a23 (vertical scale). The Kappa value is a way of expressing relative oil film thickness in the rolling interface. Calculations of the rated bearing life L10a, as given in the bearing catalogues, presupposes "full oil film lubrication", i.e. a Kappa value of at least 1, corresponding to a life adjustment factor a23 of 1.

The life adjustment factor a23 is a function of Kappa and also of other lubricant qualities, such as the additives used to prevent bearing damage. The range where additives affect the bearing life is marked by a darker shade on the graph.

On the basis of the data input for lubricant, bearing load, and bearing temperature, LUBMASTER calculates

- friction loss in Watt (Loss W)
- oil film viscosity at operating temperature (ν = Greek ny)
- minimum viscosity for L10 life (ν1)
- Kappa (ν / ν1)
- life adjustment factor (a23, depending on Kappa)
- approximate bearing life in hours (L10a h, depending on a23, load and FZG number).

The input of the lubrication data also affects the **Evaluation graph**. Without these data, LUBMASTER assumes Kappa=1 when calculating a COMP no. With the lubrication data, the program uses the actual Kappa value. Thus, you use the life time graph both for accurate calibration of the measuring point and for finding the optimal lubricant for a given bearing.

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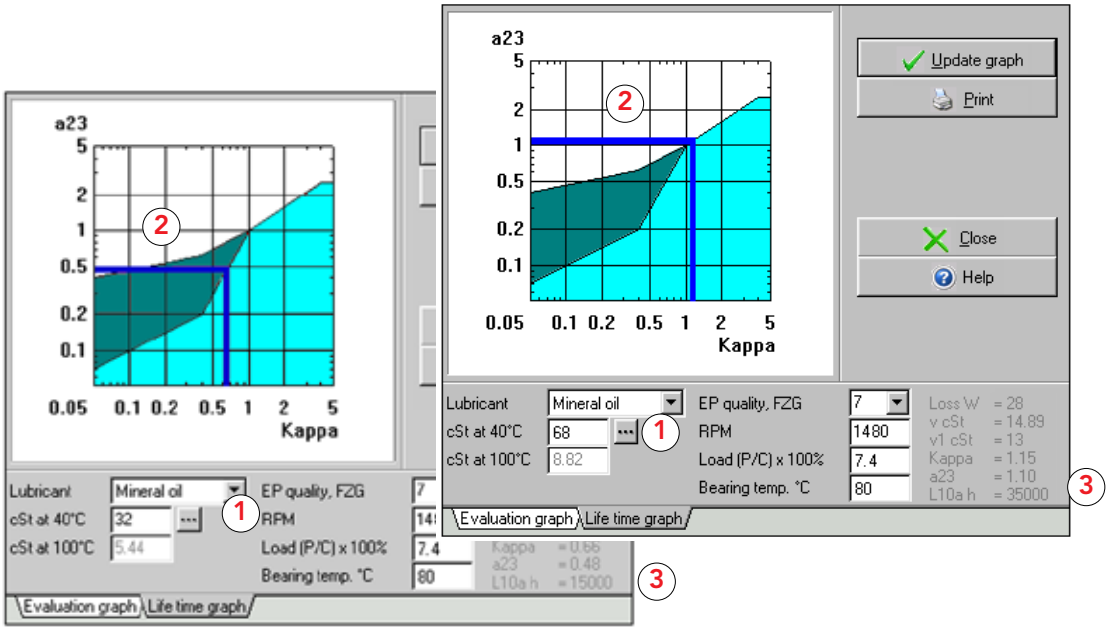

Optimizing lubricant:

- Input bearing and lubrication data. Change oil type, viscosity (1).
- Watch the life time graph (2), L10ah (3).
- Example: ISO 6310, rpm = 1480, temp. = 80 °C, load = 7.4%.

Selecting the optimal lubricant

The lifetime graph can be used to simulate different lubrication conditions for a given bearing, with the intention to find the lubricant which gives the best or at least a satisfactory lifetime for the bearing. For this, you input different oil types, viscosities, and additives, and note their effect on the Kappa value, the life adjustment factor a23, and the bearing life L10ah. In the example above (bearing ISO 6310, rpm = 1480, bearing housing temperature = 80 °C, load = 7.4%), a simple change of oil viscosity from 32 cSt to 68 cSt resulted in more than double the life expectancy.

For a proper lifetime calculation, you have input an ISO bearing number under **Evaluation graph**. If not, LUBMASTER uses default values for the dynamic bearing load C, which can have a large effect on the calculation of the bearing life. Data on bearing load, lubricant, and bearing temperature should be as accurate as possible. Temperature is measured on the bearing housing, at normal operating temperature. The program accepts values from 0 to +200 °C (+32 to 392 °F).

Lubricant type you can select from a menu: mineral oil, synthetic oil and poly-glycol. For greases, choose the type of oil contained within the grease. If your lubricant catalogue does not mention the lubricant type, you have a mineral oil. Synthetic oil includes all synthetic types except polyglycol. For synthetic oil and polyglycol you must input the viscosity at 100 °C.

When any of the lubrication parameters is changed, the evaluation graph is updated, reflecting the effect the change will have on the COMP no. and the LUB no. If the evaluation graph was obtained without lubrication data, LUBMASTER will automatically update it and set a COMP no. which shows the difference in HR at Kappa = 1 and at the newly calculated Kappa value.

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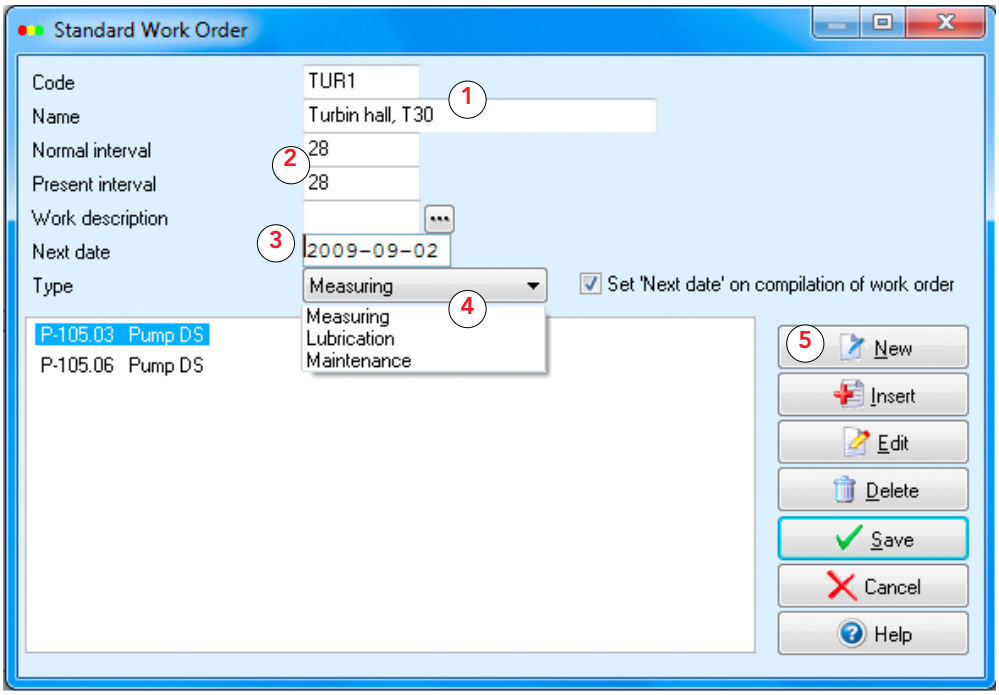

Standard work order:

- Input code and name (1), execution interval (2), next date (3).
- Select type (4). Click **NEW** (5) to select rounds / points.

Standard work order for working mode "Planning"

The working mode **Planning** is an alternative to **Data transfer** when working with handheld data loggers. The working mode is selected under **System/Settings**. When using Planning it allows you to create three types of Standard work orders:

1 Measuring: for condition monitoring with a data logger. This type of work order resembles a measuring round. However, it can contain several rounds and/or individual measuring points.

2 Lubrication: For a lubrication work order, you can print out check lists containing the lubricant data in the measuring point register.

3 Maintenance: any maintenance connected with the components and measuring points in the data base. Printout of check lists and work descriptions.

Open **Standard work orders** under **Registers** in the menu bar. Input a code, max. 4 characters, and a name (1). Under **Normal interval**, input the execution interval in days (2). **Present interval** is automatically set to the same number of days. You can edit the **Present interval** in case you want to make a temporary change in your measuring routines. **Next date** (3) is the execution date. This is automatically updated when you close the work order after execution, by adding **Present interval** to the closing date. As an alternative, you can mark **Set next date on compilation** (5). This sets **Next date** by adding **Present interval** to the day you select the work order for execution. Select the work order type from the menu (4). As an option, you can connect a work description with the Standard work order.

Click **NEW** (5) to add rounds and/or measuring points to the Standard work order.

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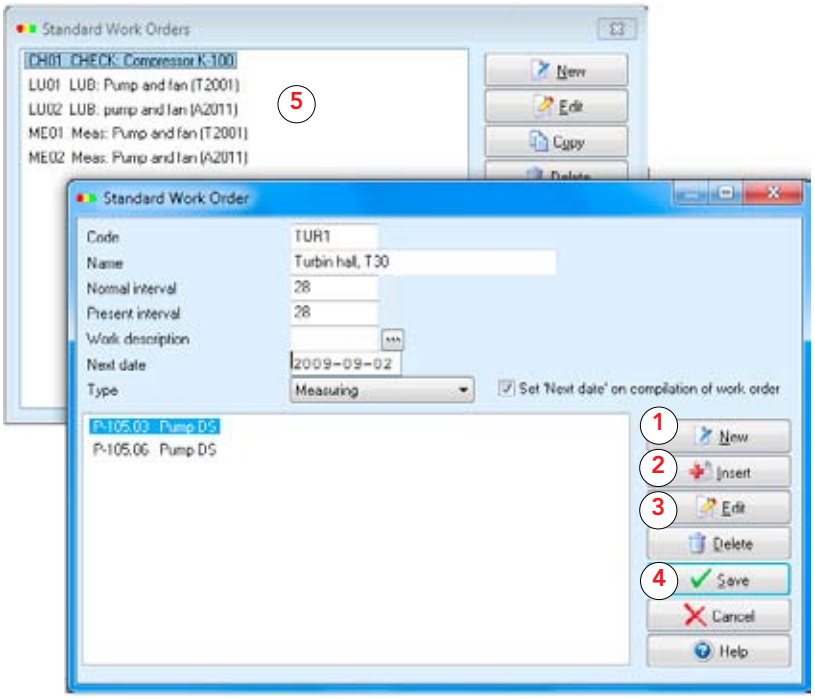

Standard work order:

- **NEW** (1) adds to the list of rounds/ measuring points.
- **INSERT** (2) adds above the marked item, **EDIT** (3) replaces the marked item. Click **SAVE** (4) to finish and add to the register (5.)

Compiling a standard work order

The content of the Standard work order is a list of rounds and/or measuring points. When you click **NEW** (1), you can select either. **Round** takes you to the measuring round register, **Measuring point** to the tree structure were you make your selection.

With the **NEW** button you add an item at the bottom of the list. **INSERT** (2) adds an item above the marked item. **EDIT** (3) replaces the marked item with a new choice. When finished, click **SAVE** (4).

Your finished standard work orders are listed by code (5). With **Planning** under **Maintenance** in the menu bar you can select Standard work orders for execution. When selected, they become **Work orders**, i. e. copies which can be edited without affecting the Standard work order.

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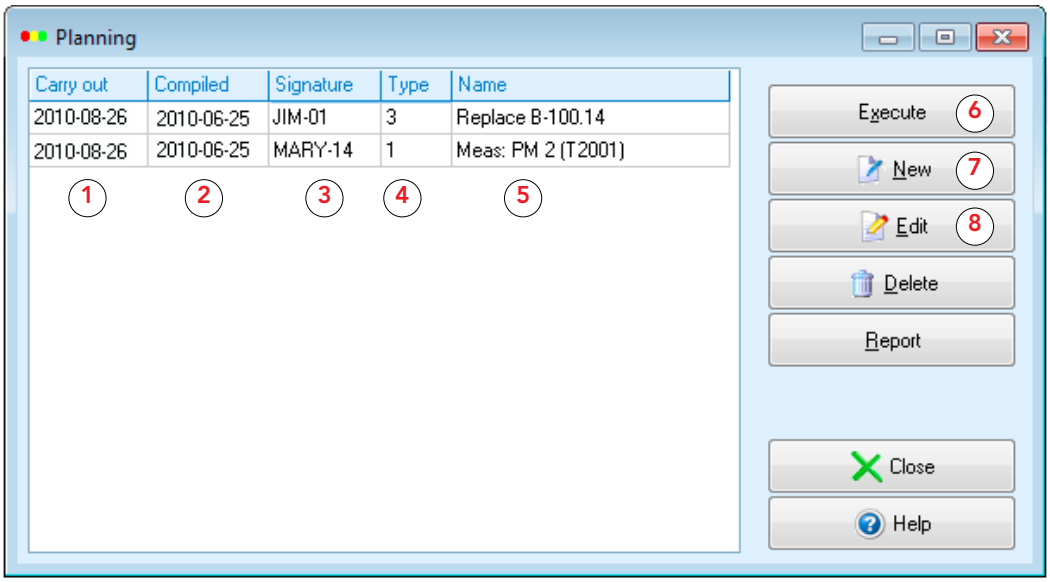

Compiling work order:

- **NEW** (1) adds to the list of work orders. Click **EDIT** (8) to make changes in the marked work order, or **EXECUTE** (6) to download and/or print checklists.

Compiling work orders

The function **Planning**, found under under **Maintenance** in the menu bar, starts with a window for compiling and editing work orders. Selected work orders are listed by execution date (1). Compilation date (2) is the date the work order was set up from here. The next column shows the signature (3) used to start Condmaster Nova when the work order was compiled. Work order type (1 = measuring, 2 = lubrication, 3 = maintenance) and name are also listed.

When the underlying Standard work order is OK, click the button **EXECUTE** (6) to download or print checklists.

With **NEW** (7), you get the Standard work order list and can select from it.

In case you want to modify the work order (without altering the Standard work order), click **EDIT** (8) and add/delete rounds or measuring points.

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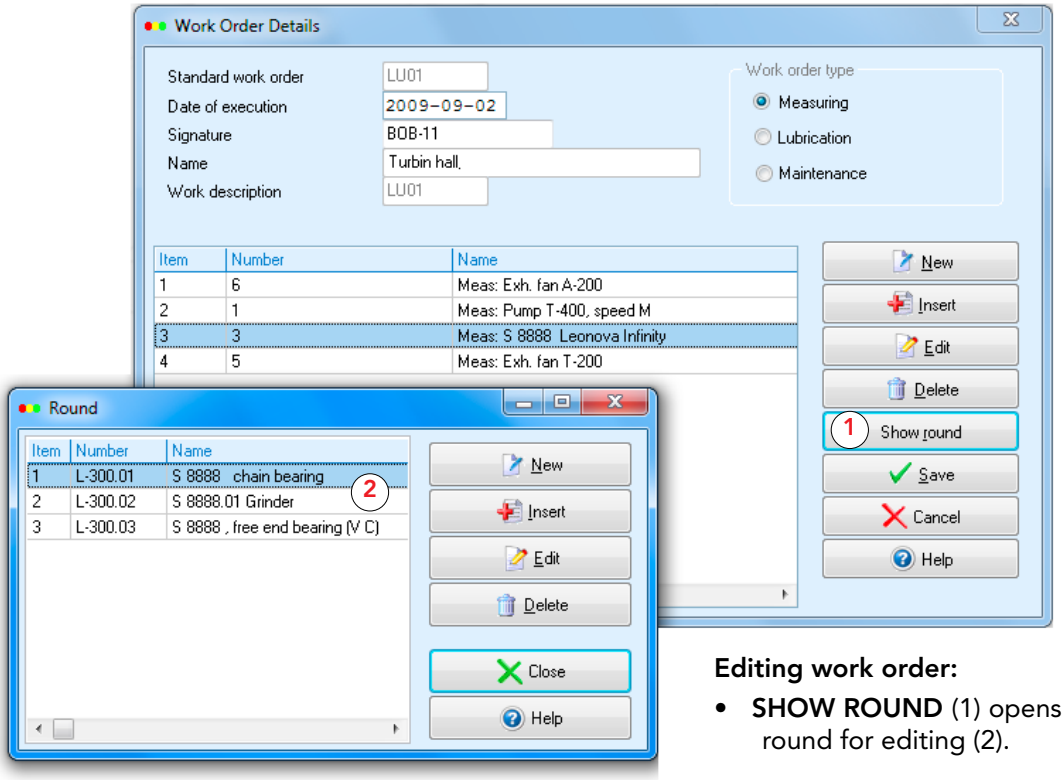

Editing work order:

- **SHOW ROUND** (1) opens round for editing (2).

Editing work orders

When editing a work order, you can use the **SHOW ROUND** button (1) to get a list of the measuring points within the round (2) and edit these. All other edit functions are the same as for making Standard work orders.

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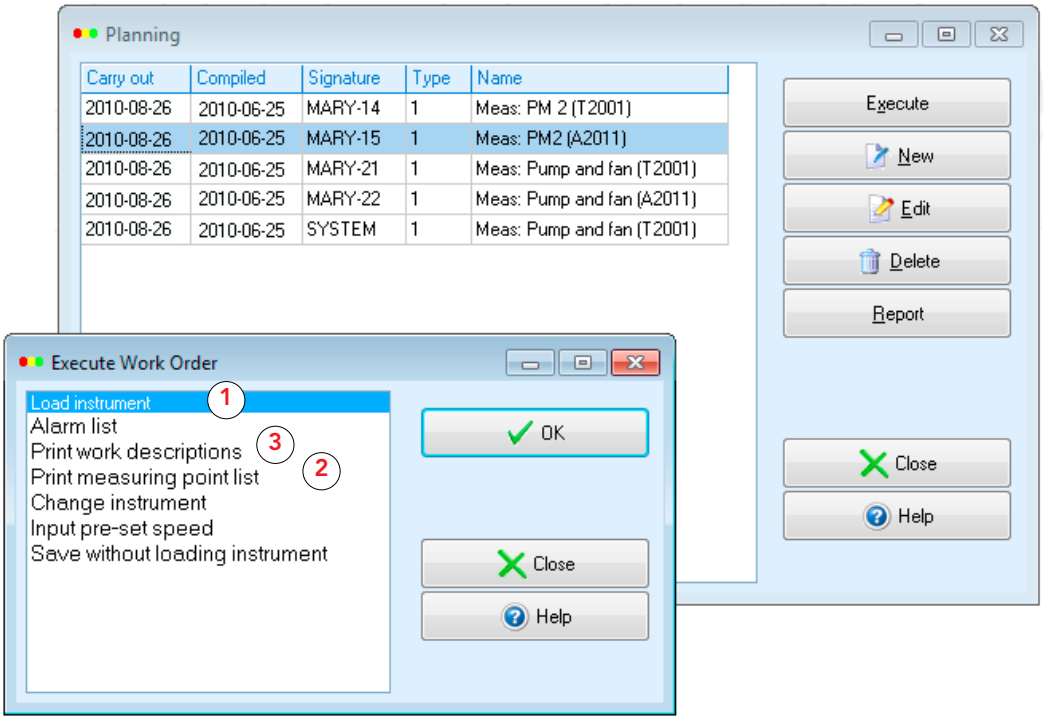

Executing work orders:

- Connect instrument and select **Load instrument** (1).
- If used, print work descriptions, check lists.

Executing work orders

The button **EXECUTE** on the main **Planning** menu opens a number of choices. **Load instrument** transfers the work order to the data logger (1). You can print out a list with all measuring points in the order (2), and the work description if you use one (3).

Change instrument allows you to download the order to another instrument than that set up for the measuring points, e. g. Machine Evaluator instead of The Machine Tester. The substitute instrument must support the same measuring techniques, and it must be activated under **Measuring system** in the menu bar.

Downloading and uploading work orders is the same procedure as for a round with **Data transfer**, see “Download to instrument” etc. in chapter “Measuring Rounds”.

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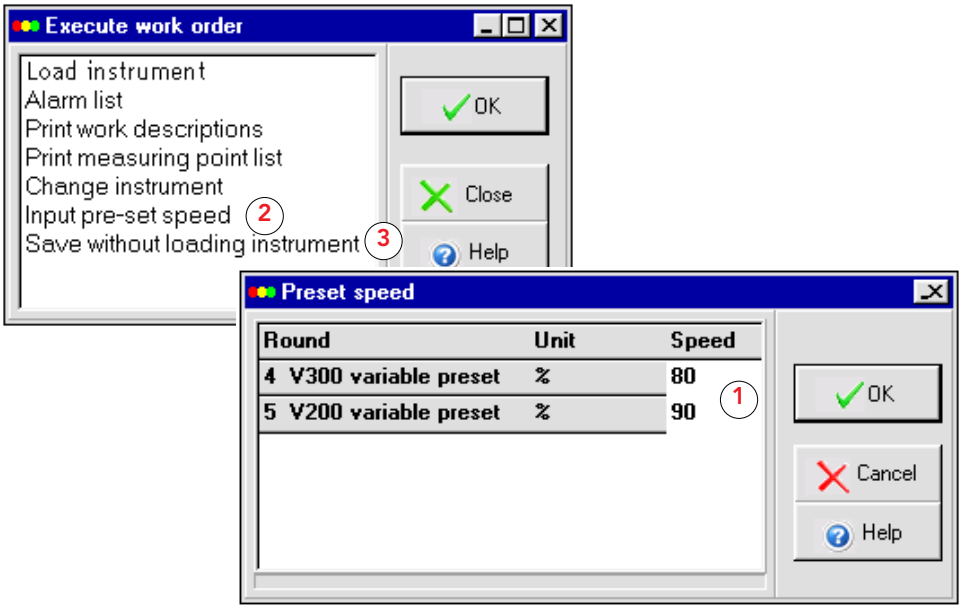

Preset speed:

- Input speed (1) while downloading or use **Input preset speed** (2) and **Save without loading instrument** (3).

Preset speed in work orders

Within the same round used in a work order, the measuring points can either have "Measured speed" or "Constant/preset speed". In case of preset speed, the second speed measuring unit (e.g. meter/min. or %) is entered. It must be the same for all measuring points in the round. The difference between max. speed and min. speed must also be the same, e.g. min. speed = 25% for all measuring points.

The work order can contain up to 10 rounds with different speed settings. For individual measuring points in the work order (but not inside a round), you cannot preset speed.

Under **Input preset speed**, you can enter preset speeds before downloading, then use **Save without downloading** to save the work order. Normally, you enter preset speeds during the downloading procedure.

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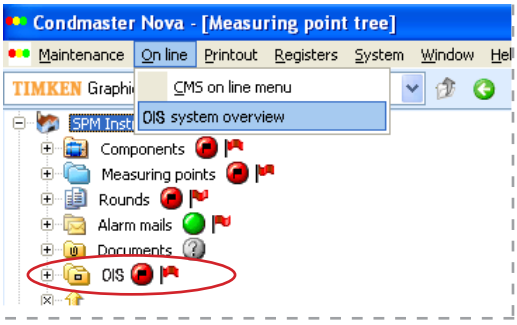
OIS functionality

Condmaster Nova 2010 has been augmented to handle measurements delivered from the OIS online system. Below is an account of the most important functions particular to OIS.

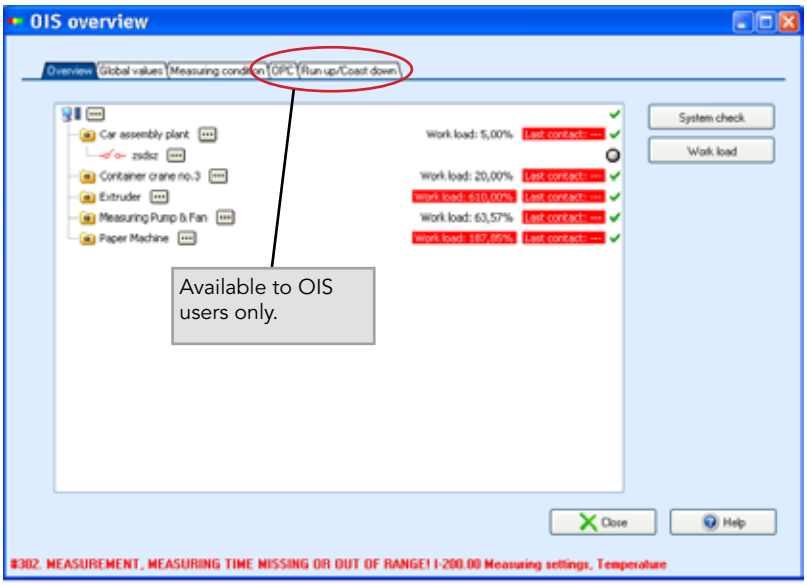
Where to find it

The measuring point tree has a new default element: the **OIS** folder, automatically created by Condmaster for OIS users. Under this folder, the OIS Commander Units, registered under **System** > **Measuring system** are listed. Under each Commander Unit in the OIS folder, measuring points may be created and configured for up to 32 channels. More information on the registration of Commander Units in Condmaster is found in the installation guide *Condmaster Nova Install and System Administration*.

The **OIS system overview** option on the **Online** menu displays an overview of all Commander Units in the system. This is also where you create global values and measuring conditions:



Commander Units are registered and monitoring units input under **Settings** for OIS, accessed via **System** > **Measuring system** in the menu bar.



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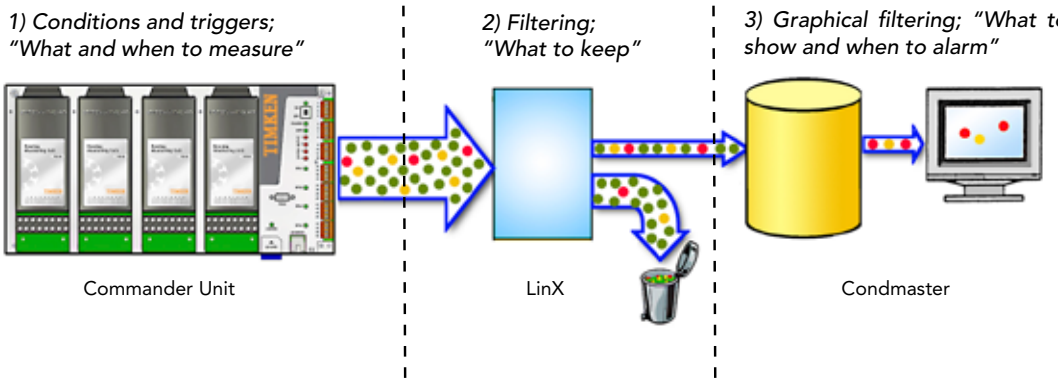
Controlling the quality and amount of measurement data

When running the OIS online system, Condmaster offers several ways to control data quality as well as the amount of measurement data saved to database. There are three different levels on which to control what is measured, saved to the Condmaster database and displayed on screen:

1) *Commander Unit level*: This is where measurement conditions and triggered measurements are handled. They are used to ensure that readings are taken only when required and at exactly the right time. If conditions and/or triggers are not fulfilled, no measurement will take place.

2) *LinX level:* LinX handles filtering of the measurement results received from the Commander Unit. The purpose is to dispense with insignificant information. Readings filtered out at this level are not saved to the database.

3) *Condmaster level*: Graphical filters are handled by Condmaster and are applied only to readings stored in the database. Graphical filtering only affects what is displayed on screen and when alarms are raised, i.e. all readings remain in the database, whether displayed or not.



Implementing stringent settings for measurement conditions and/or triggers and filtering options may cause no measuring results at all being saved to database. If this is the case, Condmaster can be set up to notify you by means of a system alarm. If such an alarm is raised, you should examine your conditions, triggers and filter settings as a first measure. This can be done using the **Measuring and storing logic** overview.

Conditions, triggers, filtering options and **Measuring and storing logic** are all accessed via the **Measuring point data** form, or via the **Graphical Evaluation**.

Measurement conditions in the Commander Unit

From the **OIS Advanced** tab on the **Measuring Point Data** form, conditions for measurement may be set up. Conditional measurements are useful for applications where measurement needs to be guided by strict rules in order to obtain consistent and reliable readings, but where the time of measurement is not critical.

A maximum of four conditions may be set up for one measuring assignment. OIS will check the status of each of the conditions in turn and measure only if all are met, otherwise move on to the next measurement task. Conditions may be based on a value measured on *another* measuring point, on rpm, digital input or local or global values. Global values, typically rpm, are accessible throughout the system.

When setting up conditions, you should be aware that when the condition is being evaluated, the *latest available reading* is used, i.e. new measurements are not necessarily carried out for each condition evaluation. For instance, if you base a condition for measuring point A on the dBc value of measuring point B and this

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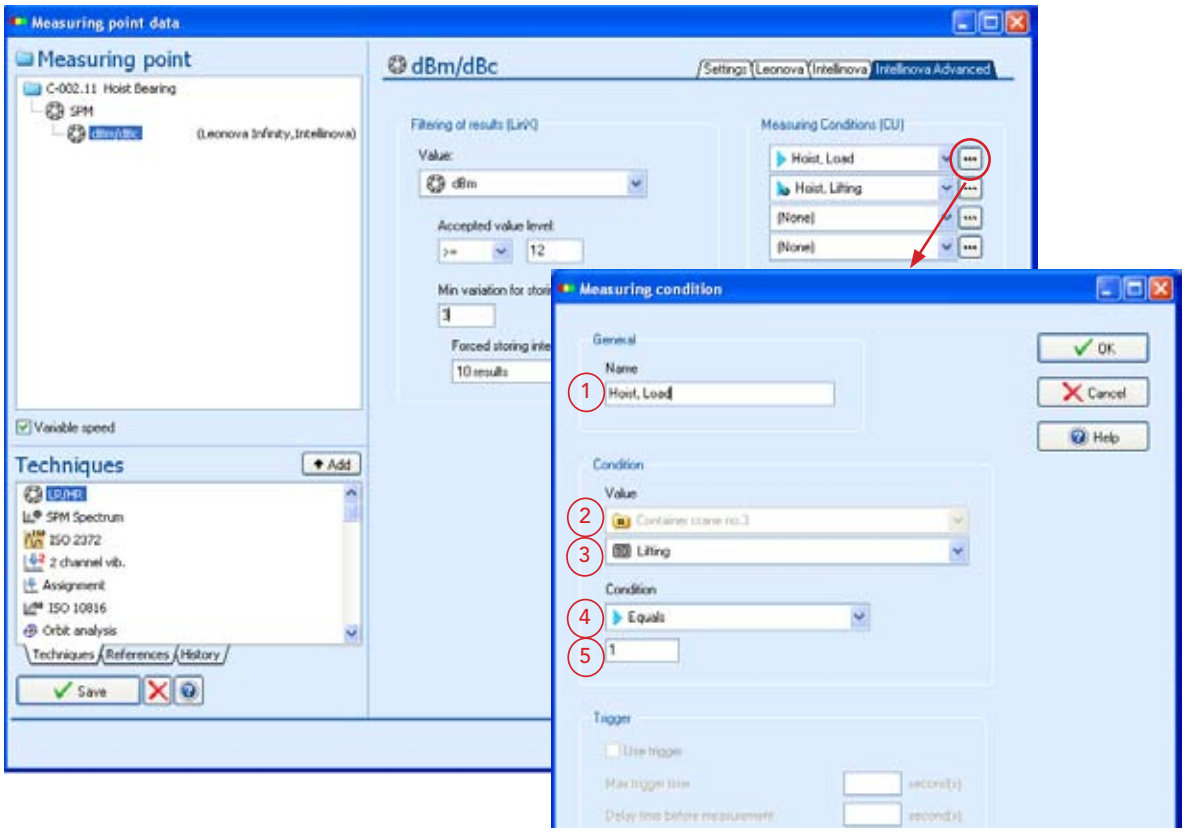
is measured once every 60 minutes, then the condition may use a reading that is up to one hour old. The exception is when using rpm or digital input as conditions; these are continuously measured by the Commander Unit and will therefore always be new and "just-measured".

Example: Vibration measurement on crane

Condition	***Implication***	***Action***	
1) Rpm in range 15 to 60	Crane is in operation	If yes, check next condition. If No, abort.	2)
Hook load over 10 tons	Load variation is acceptable	If yes, check next condition. If No, abort.	3)
Digital input equals 1	Crane is lifting	If yes, measure. If No, abort.	

Conditions are set up on the **OIS system overview** > **Measuring condition** tab, which you access either from the **Online** menu in Condmaster or from the **Measuring Point Data** form, using the "**...**" button on the **OIS Advanced** tab. The process is as follows:

1. From the **Measuring condition** tab in the **OIS System Overview form**, click **NEW** to create a new condition and name it.
2. Select **Global value** or the Commander Unit under which the measuring point implementing the condition is registered.
3. Select a global value or something measured by the Commander Unit selected in step 2).
4. Select a condition (**Over**, **Under**, **In range**, **Out of range** etc.) to be evaluated.
5. Input one (or two) condition value(s).
6. Save the condition, return to **Measuring point data** and select it from the dropdown list under **Conditions**.



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Triggered measurements in the Commander Unit

Like conditional measurements, triggered measurements are a way to guarantee that measurement is carried out in a controlled manner. The difference is that triggers are used for time critical measurements.

By definition, triggers are *event-driven* and will execute in response to a change of some sort (e.g. digital input changing from 0 to 1 or RPM falling below a certain level). This means they are appropriate for use when it is imperative that measurement be done *only when a certain situation occurs*.

Let's say you set a condition that a certain DI should go from 0 to 1. If, and only if, this happens within the specified time frame (**Max trigger**), that is the event that triggers the measurement.

Triggers may be based on digital input, OPC or rpm originating from the Commander Unit to which the measuring point implementing the trigger is connected.

It is possible to implement conditions only, triggers only or a combination of both. In the latter case, conditions take priority and so will be evaluated before the trigger.

Example:

On an automotive lifting device, measurement should be carried out only when the device is lifting. A trigger is therefore set up for a certain rpm, say 300. The system will then halt and wait, for a user defined period of time (**Max trigger**), for rpm to pass this limit. If this happens within the trigger time frame, it will wait for another user defined period of time (**Delay time**) for rpm to become sufficiently stable, and only then will it start measuring.

Triggers are set up on the **OIS Advanced** tab in the **Measuring Point Data** form, or via the **Online** menu > **OIS System Overview**. The process is as follows:

1. From the **Measuring condition** tab in the **OIS System Overview form**, click **NEW** to create a new trigger and name it.
2. Select the Commander Unit to which the measuring point implementing the trigger belongs.
3. Select rpm or digital input measured on that Commander Unit.
4. Select a condition to be evaluated among those having a dark blue icon, and input a value (e.g. 500 rpm).
5. Tick the **Use trigger** checkbox and input **Max trigger** (i.e. time to wait for trigger condition to be met) and **Delay time before measurement** (time to wait before starting measurement).
6. Save the condition, return to **Measuring point data** and select it from the dropdown list under **Conditions**.
7. In the **Measuring point data** form, input a **Retry trigger time** (i.e. time to wait before checking the trigger condition again if it wasn't passed the first time), which should be equal to or shorter than the **Measuring interval** set up under the **OIS** tab. This is to prevent a situation where the trigger condition is never met.

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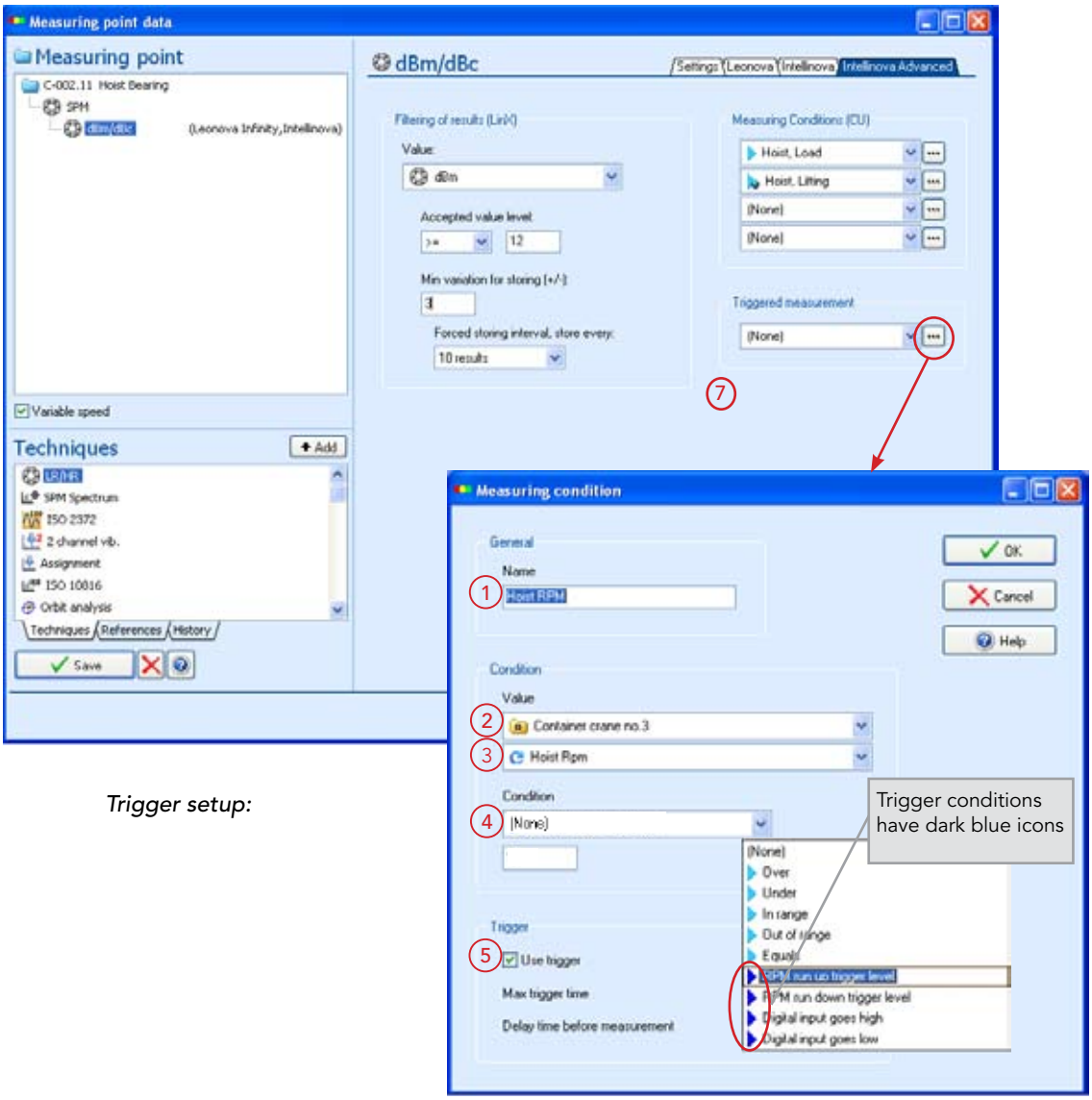

Trigger setup:

Filtering of measurement results in LinX

Filtering of results can be used to discard unwanted readings, e.g. those taken while a machine is not running, or to limit the amount of readings saved to database when measurement frequency is high and readings don't change much over time. Filter settings will not impact the setup of individual measurements, which will always take place at the user defined intervals (providing they meet any conditions and/or triggers set up). Filtering only affects what is saved to database. However, readings that have been filtered out can still be used as measurement conditions.

When filter settings are implemented, the system evaluates each new reading against *the latest reading saved* to database according to your filter settings:

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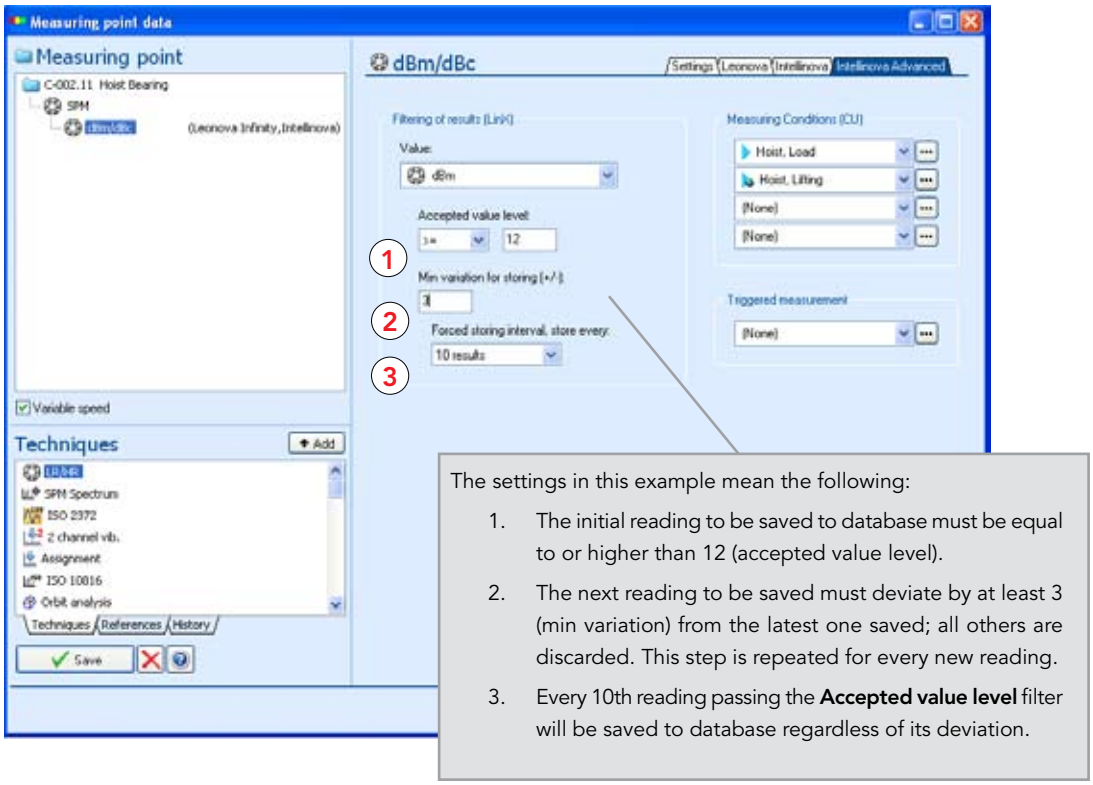

Use the **Min variation for storing** parameter to avoid saving readings that don't differ significantly from the latest one stored. This way, you don't save an unnecessary amount of data, but still capture enough results to see an evolving trend.

In theory, you might set the **Min variation....** in such a way that nothing ever gets past the filter. That's why by default it is combined with the **Forced storing interval...** parameter. This parameter forces the system to save readings on a regular basis (providing they pass the **Accepted value level** filter), thereby confirming that measurement is indeed carried out and working properly.

Graphical filtering in Condmaster

Graphical filtering is done using the **Alarm delay** function, accessed from the **Measuring Point Data** form. **Alarm delay** filters out randomly high readings from display and determines when alarms will be raised. Readings filtered out this way remain in the database; they just aren't shown in the **Graphical Evaluation**, and no alarms are generated for filtered-out readings.

Graphical filtering is not exclusive to OIS; it is a function open to all Condmaster users.

For a key to the measuring and storing logic overview, please see overleaf.

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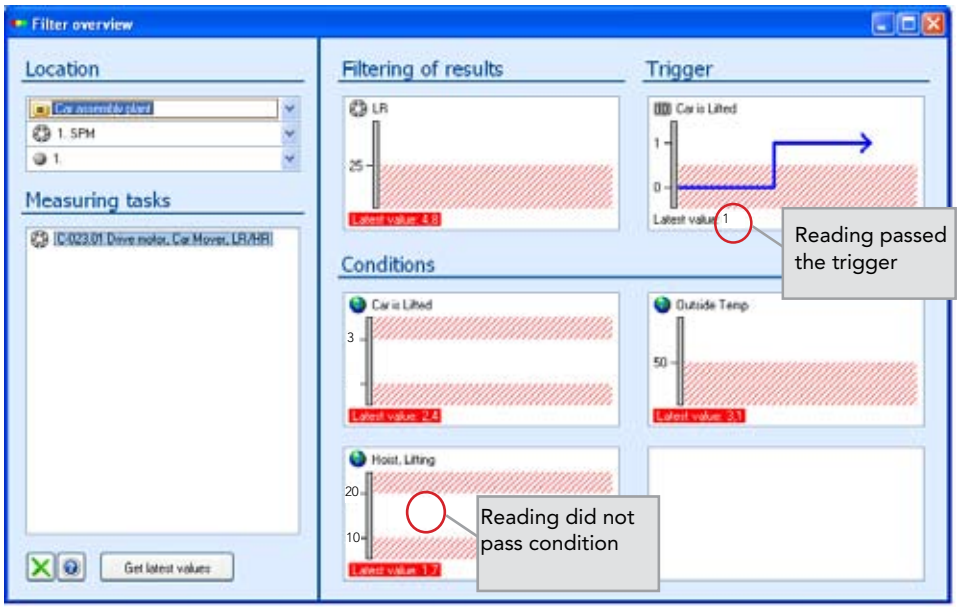
Measuring and storing logic overview

Measuring and storing logic is an overview feature that provides an overview of all conditions, triggers and filters set for the selected measuring assignment. Make use of this function to verify that you have not implemented filter settings, conditions or triggers that will cause all readings to be discarded.

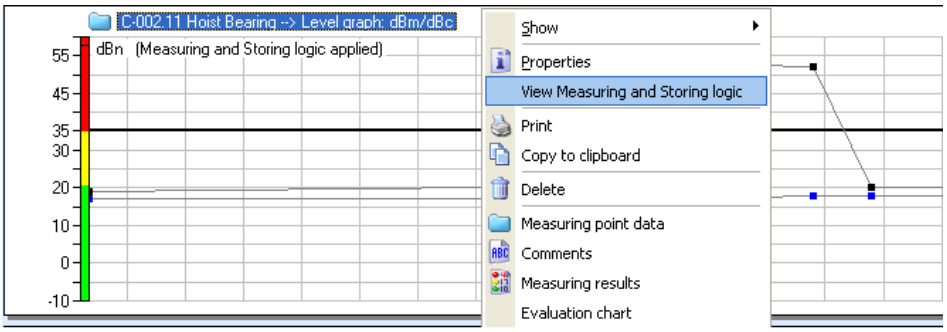
The **Measuring and storing logic** overview is accessed from the bottom right corner of the **OIS Advanced** tab on the **Measuring point data** form.

Under **Location**, select a Commander Unit, monitoring unit and channel to view (see above). Under **Measuring task**, select a measuring assignment. The present settings are displayed to the right:



To have a look at the latest readings, click the **GET LATEST VALUES** button. The latest values that were evaluated against your filter(s), condition(S) and trigger(s), are displayed and you'll be able to determine whether the filter settings etc. are reasonable. Values not accepted for storing appear in red, and if they continue to do so when you get the latest values again, then your filter settings need to be reviewed.

You can also access the **Measuring and storing logic** overview from the **Graphical Evaluation**:



For a key to the measuring and storing logic overview, please see overleaf.

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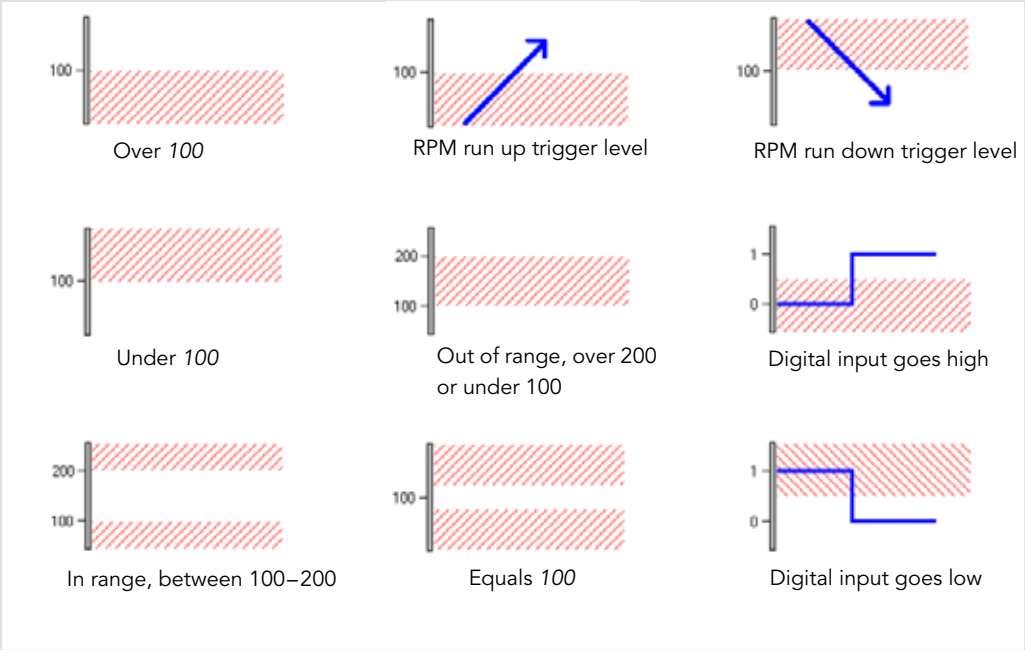
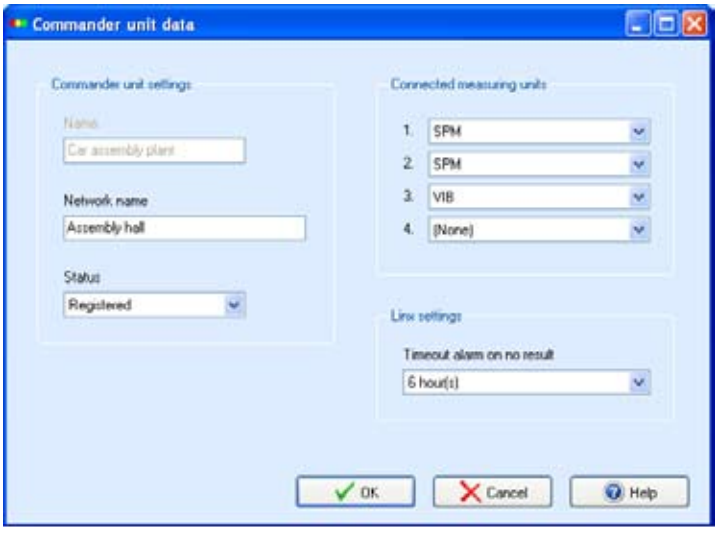
Key to Filter overview graphs



When no measuring results are coming in

When no OIS measuring results are saved to database, you'll want to know so you can start troubleshooting. You should therefore set Condmaster up to raise an alarm if this situation occurs.

This is done in the **Commander unit data** form, found under **Settings** for OIS (accessed via **System** > **Measuring system** in the menu bar), where you also register Commander Units and tell the system what monitoring units are on board:



To get a "no measuring results alarm", select an appropriate time frame from the **Timeout alarm on no result** dropdown list under **LinX settings**. Default setting for this function is OFF.

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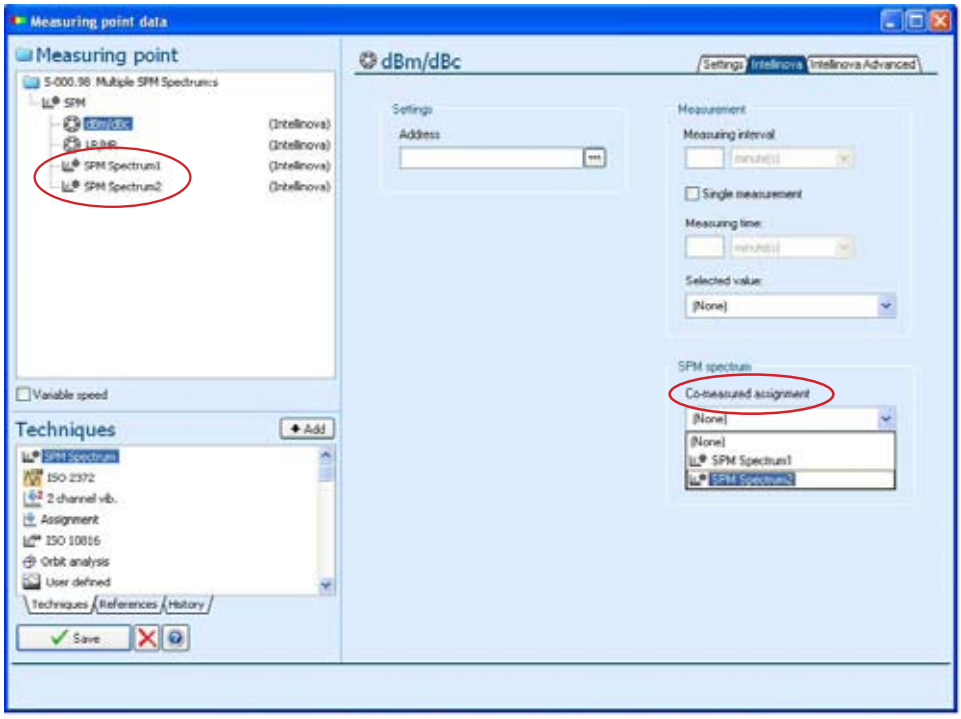
Multiple SPM Spectrum assignments

For OIS, multiple SPM Spectrum assignments may be set up for the same measuring point. For best spectrum results, it is recommended that you select one SPM Spectrum assignment to be measured in immediate connection with your dBm/dBc or LR/HR measurement. This is the **Co-measured assignment** parameter under the **OIS** tab.



Furthermore, the **Lower frequency** parameter is now available also for SPM Spectrum measurements.

Run up / Coast down measurement

Run up/coast down measurement with OIS can be performed from Condmaster. This function is found under **Online** > **OIS system overview** in the Condmaster menu bar (overleaf):

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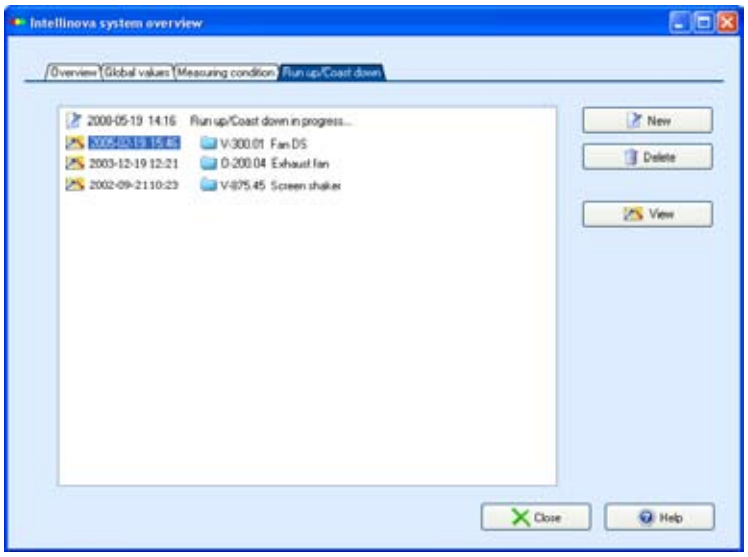
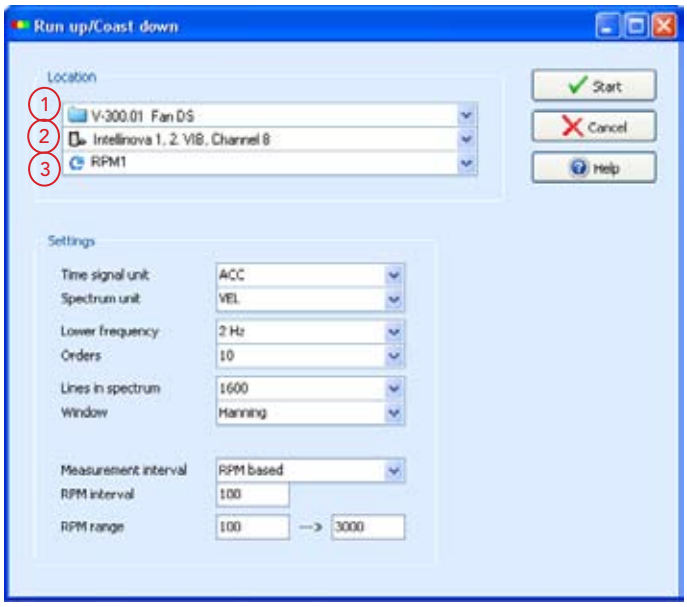


On the **Run up/Coast down** tab, all previous run up/coast down measurement results (if any) are displayed, and new measurements can be initiated via the **NEW** button.

Under **Location**, select:

1. a measuring point under which to store the run up/coast down measurement result
2. a channel to use on the Commander Unit to which the measuring point belongs
3. an RPM value

Please note that only RPM channels local to the selected Commander Unit can be used. Input your preferred settings and click **START**. This run up/coast down measurement will now overrun whatever task LinX is working on. When measurement is completed, LinX will return to the Commander Unit task file and resume work where it was interrupted.



To abort a run up/coast down measurement, mark it on the list of measurements on the **Run up/Coast down** tab and press < DELETE > on your keyboard.

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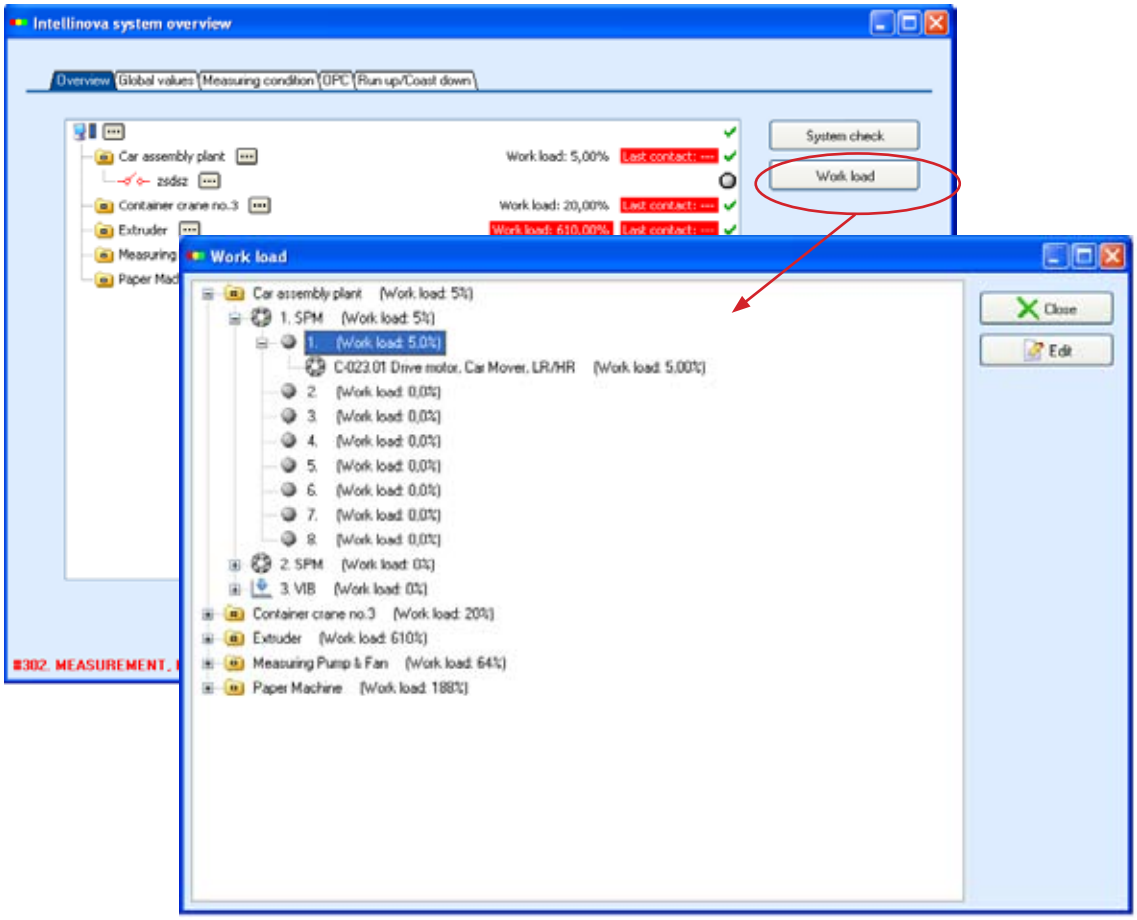
Monitoring unit workload

In the **OIS System Overview** under the **Online** menu, an estimate of the workload of each Commander Unit can be viewed. Click the **WORK LOAD** button on the **Overview** tab to view the workload of each individual monitoring module and channel. It tells you how busy the Commander Unit hardware resources are.

Work load is a helpful feature e.g. if you need to figure out why measuring results aren't coming in at the



intervals set up in Condmaster. Possible reasons might be:

- hardware malfunctions
- measurement conditions or triggers too restrictively set
- nothing gets past your filter settings
- unduly high Commander Unit workload

Work Load is *an estimate* of the *maximum* ***theoretical*** *workload*. A high workload percentage implies that the Commander Unit hardware is very busy and may be unable to carry out measurement assignments according to the set up measurement intervals. However, the ***actual*** *workload* may be considerably less. Measurement conditions and triggers need to always be evaluated at the specified intervals, which takes some amount of effort on behalf of the hardware (theoretical workload), but if the conditions and/or triggers aren't met no measurement will take place, thus lowering the actual workload.

Ideally, measuring assignments should be evenly distributed among the available channels. SPM Spectrum measurements in particular require multiple hardware resources.

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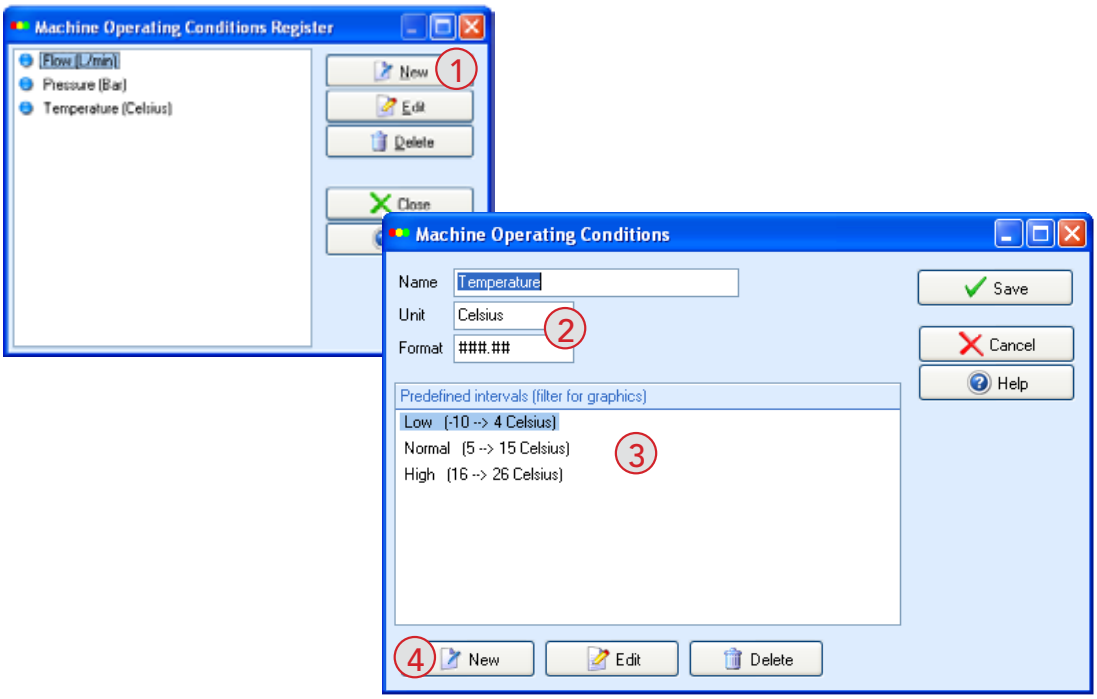
Machine operating conditions

In Condmaster Nova 2010, OIS users can measure machine operating conditions such as power, speed, pressure, flow etc. in connection with vibration measurement. Based on these readings, alarm limits can be set in the Condition Manager. Machine operating conditions can be measured through the OIS analog monitoring unit, connected to a temperature or pressure gauge, for example, or via the RPM input. They can also be imported via OPC.

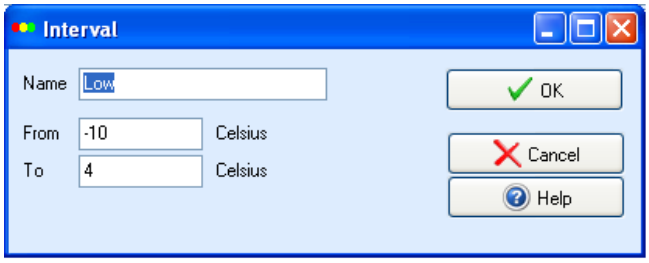
Throughout Condmaster, a light blue "dot" icon symbolizes machine operating conditions:

To start using machine operating conditions, follow these steps:

1. Define the new operating condition under **Registers** > **Machine Operating Conditions** > **NEW** button (1):



2. Name the operating condition and input a unit of measurement and a format (2).
3. **Predefined intervals (filter for graphics)** (3) is an optional setting. Any intervals input here can be used in graphics to filter out results you don't want to see at a given time. Click the **NEW** button(4) to enter intervals for graphical filtering:



4. Each machine operating condition needs to be "associated" with a measured value. Your next move is therefore to set up how this particular value is measured. The alternatives are:

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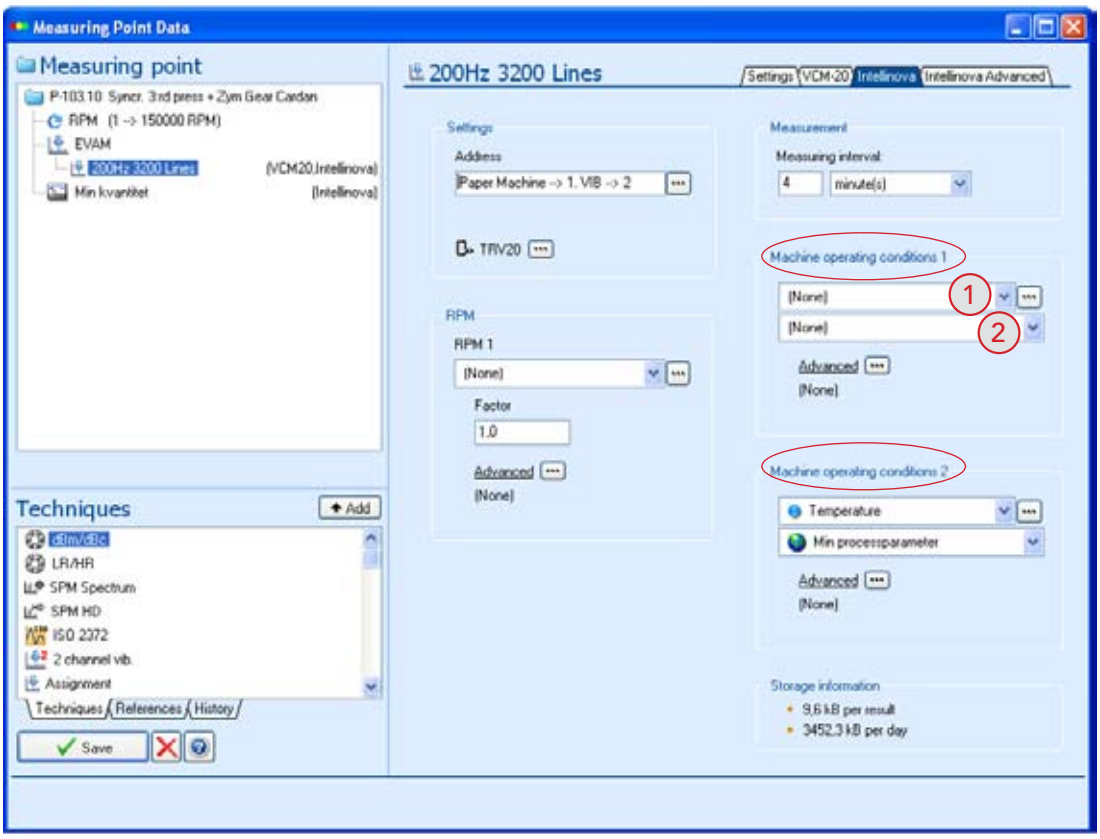
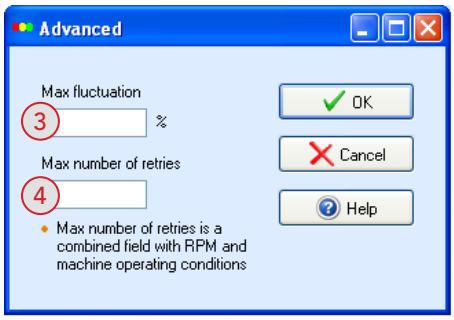
A) as a global value (under **Online** > **OIS System Overview** > **Global values** tab) and/or
B) as a **User defined** measuring assignment on a measuring point.

1. Next, you'll need to make the actual "association" between the named operating condition and the measured value. Select the measuring point where the machine operating condition is to be used and open the **Measuring point data** form:



2. On each measuring assignment, two machine operating conditions may be used. In the upper dropdown list under **Machine operating condition 1**, select an operating condition (1).
3. In the lower dropdown list (2), select the origin of the measured value, i.e. a global value or a user defined measurement.
4. Under the **Advanced** '**...**' button, further settings can be made:



Max fluctuation (3) represents the maximum fluctuation of the measured value allowed during the measurement time. If it varies more than the percent input here, the measurement is considered failed. **Max number of retries** (4) is the number of times the Commander Unit will try to measure before measurement is considered failed.

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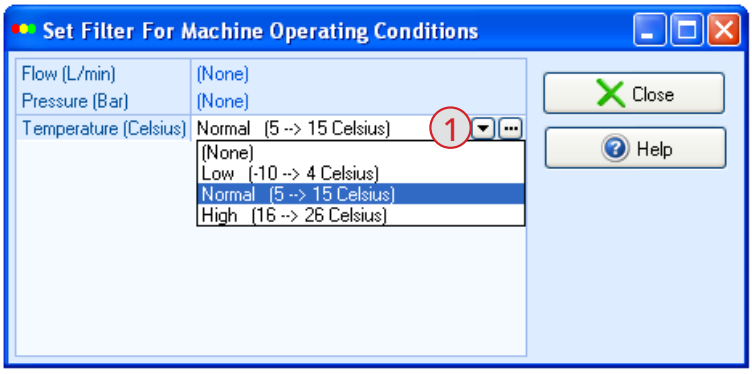
Setting graphical filters for machine operating conditions

If **Predefined intervals** have been set up in the **Machine operating conditions** register, you can use them to filter out what you want to see in the Condmaster graphics. The filters will apply to **Graphical evaluation**, **Spectrum** and **Compare spectrum**. However, from each of these Condmaster functions, other filter settings can be made.

1. Click on the '**...**' button in the Condmaster menu bar and select **Set filter for machine operating conditions**:

2. In the dropdown list of the operating condition you wish to filter on (1), select an interval. Note that only one interval can be selected per operating condition. Readings falling into the selected interval will be displayed in graphics; all others will be left out.



3. Under the '**...**' button, other predefined intervals can be selected. A new and temporary interval, not defined in the **Machine operating conditions** register, can also be input here.

The blue **Machine operating conditions** icon is available in **Graphical evaluation**, **Spectrum** and **Compare spectrum**, so filter settings can be changed from there.

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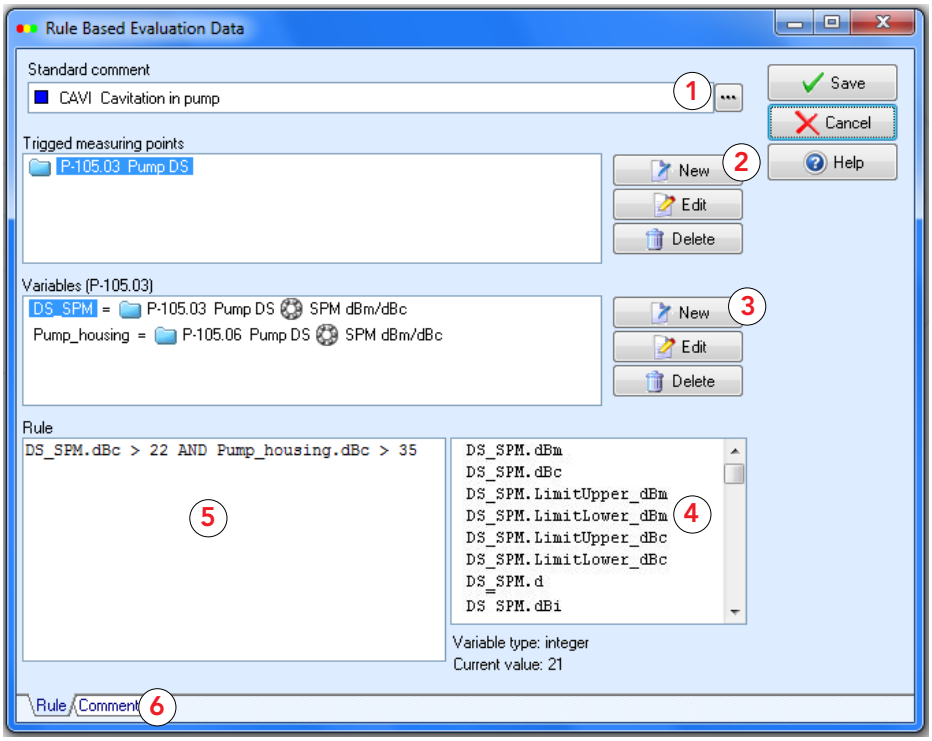

Rule Based Evaluation, RBE

The purpose of the optional module RBE is to give guidance on what to do when certain conditions are met.

To define an RBE alarm, go to **Maintenance** in the menu bar and select **Rule Based Evaluation**. Click **NEW** to create a new RBE alarm (or **EDIT** to make changes in an existing setup).

In the **Rule Based Evaluation data** form, click "**...**" (1) under **Standard comment** to select a comment that will be set when the RBE rule is fullfilled.

Under **Triggered measuring points**, click **NEW** (2) and make your selection from the list of measuring points. For each trigged measuring point, click **NEW** (3) under **Variables** to name a variable (use descriptive names), e.g. Pump_Housing, and select a measuring technique. Depending on the choice of technique, the variables are automatically assigned certain *properties* which can be evaluated by rules.

Rules are set up in the lower part of the form, where a list of operators and variables is displayed to the right (4). At the bottom of this list are the variables, with their respective *properties* following the variable name, e.g. Pump_Housing.*LimitUpper_dBm*. Double click in the list to select the variables involved and the appropriate operator(s), which are then displayed under **Rules** to the left (5). To remove a variable or an operator from the **Rules** list, mark it with the mouse, then press Delete on your keyboard.

The example rule in the figure above, "DriveSide_SPM.dBc > 22 AND Pump_Housing_SPM.dBc > 35", means an alarm will be triggered when the dBc value on the drive side exceeds 22 ***and*** the dBc value on the pump housing exceeds 35. Use the **Comment** tab (6) to indicate what actions should be taken when this particular alarm is triggered, e.g. "Open inlet valve". Photographs etc. may be attached for illustrative purposes.

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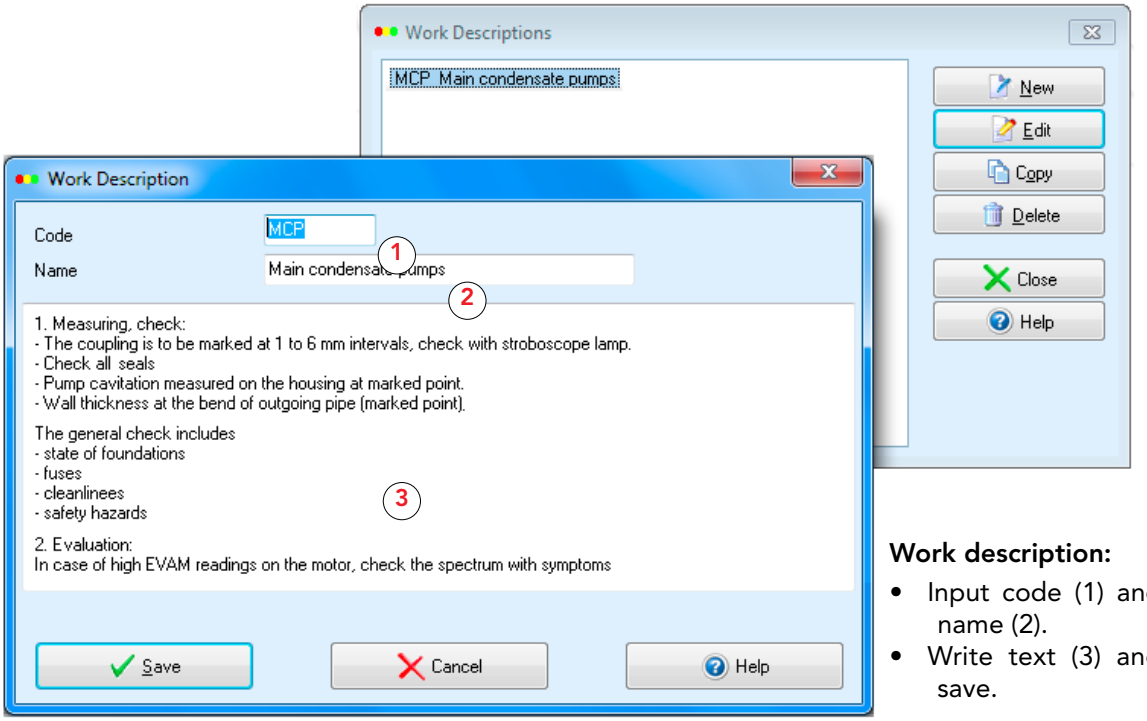

Work description:

- Input code (1) and name (2).
- Write text (3) and save.

Work descriptions

Work descriptions, found under **Registers/Work descriptions** in the menu bar, can be attached to measuring points, components, rounds, and work orders. They consist of a code (1), max. 4 characters, a name (2), and free text (3).

Work descriptions are free standing objects, stored in the work description register. They can be attached to more than one item. When attached to a round or work order, you can print them when downloading to the instrument.

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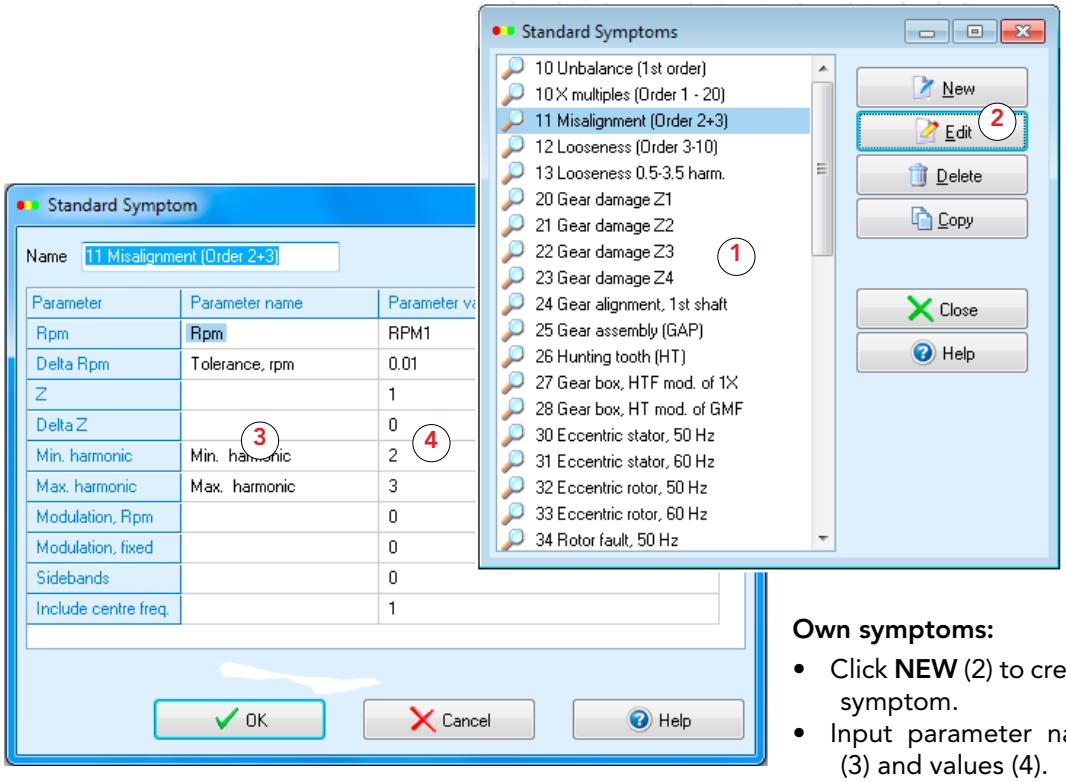

Own symptoms:

- Click **NEW** (2) to create a symptom.
- Input parameter names (3) and values (4).

Standard symptoms for EVAM

This register contains the standard symptoms used for spectrum analysis of EVAM measuring results. You can create your own symptoms, save them under a name and input the parameter names and values. For details, see the separate instruction "Standard symptoms in Condmaster", number 71584B.

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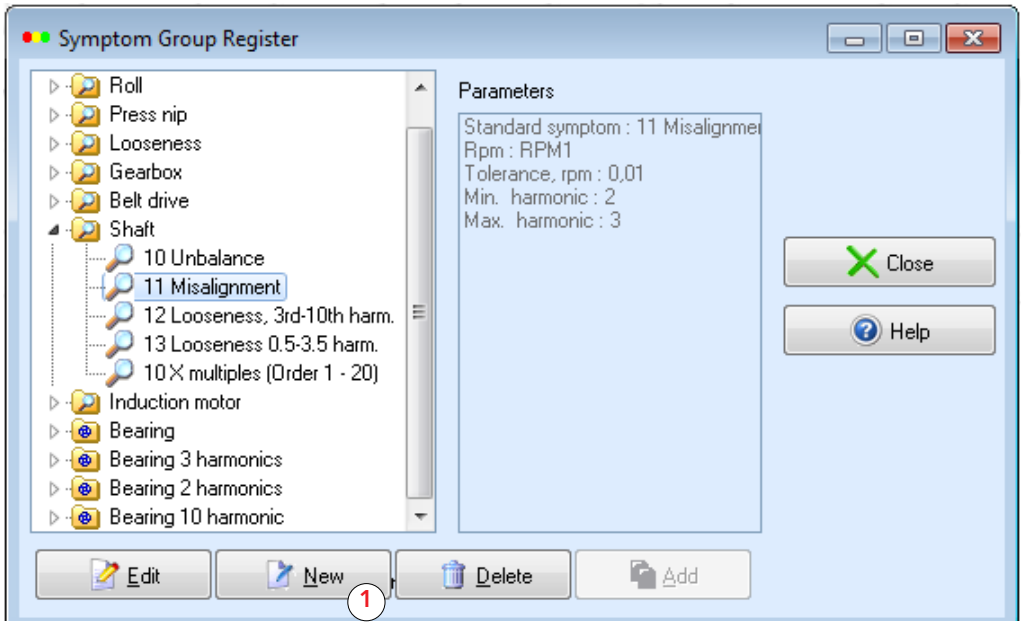

Own symptom groups:

- Click **NEW** (3) to create a symptom group.
- Select standard symptoms.

Symptom groups

A symptom group consists of two or more standard symptoms and can even contain other symptom groups. By saving the typical symptoms of a machine part, e. g. a shaft with its bearings, as a group, you can quickly attach all those symptoms to an EVAM assignment.

Bearing symptoms are always a group, because the rotational speed of the shaft has to be multiplied with different factors to define the frequencies of inner ring, outer ring, and cage. The whole group is configurated together when you input the shaft rpm and the ISO bearing number under one of its symptoms.

Click **NEW** (1) to create a symptom group, select standard symptoms from the list and save under a name.

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Report Manager

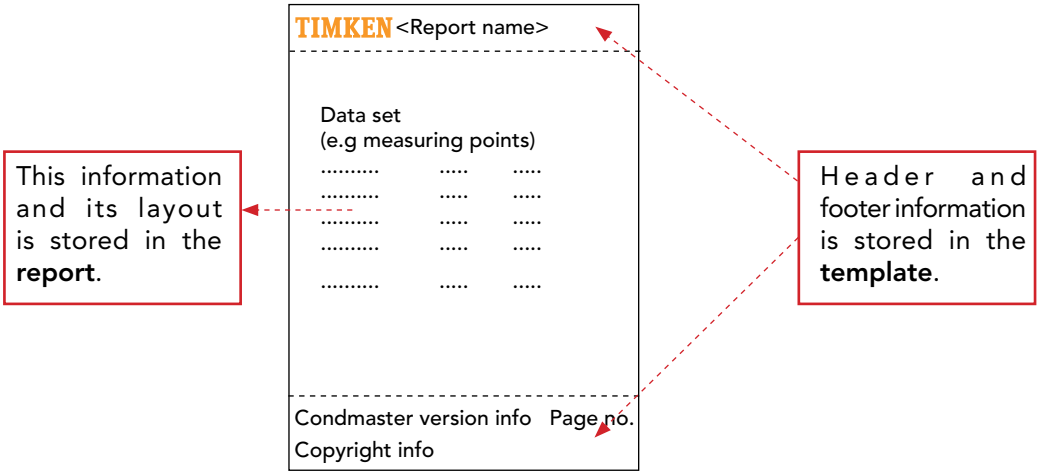
Condmaster Nova 2010 comes with a new function called the **Report Manager**. This function provides a number of standard reports of database items such as components, measuring points, measuring rounds, alarm list etc.

The **Report Manager** is accessed via the **Report Manager** menu in the Condmaster menu bar:

The reports can be previewed on screen, printed, saved as pdf, exported and imported. Most reports also offer sort order and other options.

Understanding how reports are composed

Each report is composed of a template and a collection of database items:


TIMKEN <Report name>
Data set
(e.g measuring points)
This information and its layout is stored in the report.
Header and footer information is stored in the template.
Condmaster version info Page no.
Copyright info

It is important to understand the difference between a template and a report, and the relationship between the two.

The standard Timken templates contain a page header, printed only on the first page of every report, and a footer, which is copied onto every report page. That's all.

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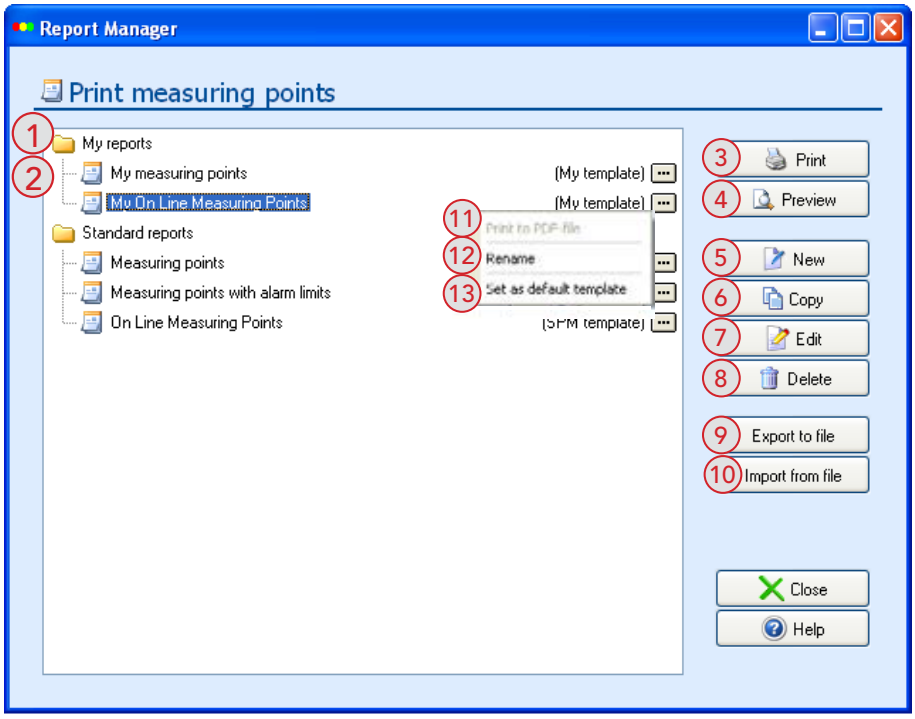
The "bulk" of a report on the other hand is a set of data, collected from the Condmaster database and laid out according to the individual report design. Depending on the type of report and the amount of data in your database, this bulk of information can range from a few rows to many pages.

Every time a particular report is generated, *the template is merged with the current bulk of data*. This means there must be a "connection" between the default template and every individual report. For all standard reports, this connection has been set up by Timken. However, if you want to make changes to a standard Timken template or report, you need to make a new connection yourself (see section '*Customzing the standard templates*').

Report Manager functions

Each menu option displays the **Report Manager** window (see screen dump below), where a tree structure in turn presents the reports available to you. Two file folders are always present in the tree:

- **My reports** (1): Under this folder, you'll find any reports you have created yourself.
- **Standard reports** (2): Reports developed by Timken are found under this folder. They come with the system and cannot be edited, deleted or renamed.



PRINT (3): Send report straight to printer without preview (not applicable to templates)

PREVIEW (4): Preview report on screen before printing (not applicable to templates)

NEW (5): Create a new report from scratch in the report generator tool. The new report will be saved under **My reports** for the database item selected (Components, Measuring rounds etc.)

COPY (6): Open a copy of the current report in the report generator tool, where you can edit the copy and save it *under a new name* under **My reports**

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EDIT (7): Open the current report in the report generator tool so you can edit and save it *under the same name* (this option is available only for **My reports**)

DELETE (8): Delete the current report (this option is available only for **My reports**)

EXPORT TO FILE (9): Export the current report (in FastReport file format)

IMPORT FROM FILE (10): Import a report (in FastReport file format) and save it under **My reports**

Functions under the '**...**' button:

Print to PDF file (11): Create a copy of the current report in pdf format (not applicable to templates)

Rename (12): Rename the current report (applicable to **My reports** only)

Set as default template (13): Select this template to be the default template for all reports (applicable to templates under **My reports** only)

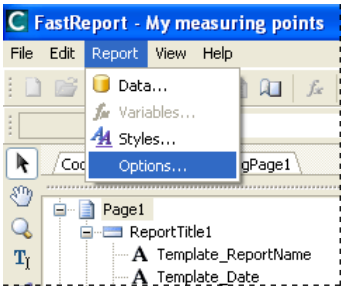
Customizing the standard templates

The standard templates delivered with Condmaster contain the Timken logotype and a report name assigned by Timken. If you prefer your own logotype or any other change to a report header or footer, follow these steps:

1. In the **Report Manager** menu, select **Templates**.
2. Mark a standard template and click **COPY**. The report generator tool, FastReport, opens inside Condmaster. For more information about FastReport, please see section '*Designing your own reports*'.
3. Make your changes in FastReport.
4. Click the **SAVE** button in the FastReport tool bar. You are prompted to enter a name for the new template. When you have done so, close FastReport. The new template is now found under **Templates** > **My Reports**.
5. Mark the new template, click the '**...**' button and select **Set as default template**.

   At this point, your changes do not affect any of the reports, i.e. when you print or preview them, they will still have the standard Timken header and footer. To have your template changes reflect on the reports, you need to make a copy of a given report, then make a new connection between that report and your new template. Follow these steps:

6. In the **Report Manager** menu, select a database item for printout (Components, Measuring points, Comments, etc.).
7. Select an individual report in the **Report Manager** window. For a standard report, click **COPY**. For a report in the **My reports** folder, click **EDIT**. FastReport opens within Condmaster and displays the design of the report.
8. In the FastReport menu bar, select **Report** > **Options**:



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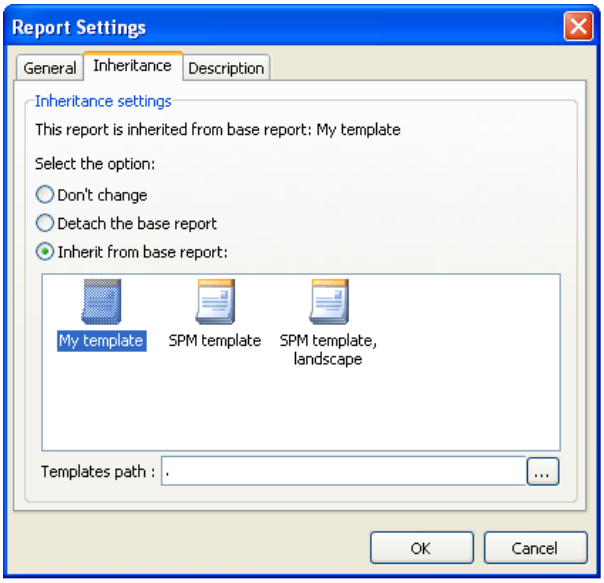
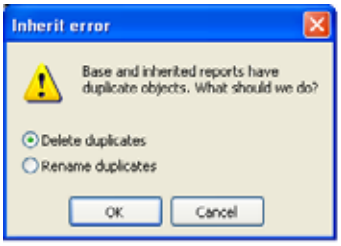
1. The **Report settings** window is displayed. Click on the **Inheritance** tab:



2. Among the option buttons, select **Inherit from base report**, then mark the template you created earlier. Click **OK**.
3. When FastReport displays the following warning message, select **Delete duplicates** and click **OK**:



4. Save the report. If it is a copy of a standard report (see under 7) above), you are prompted to give it a new name.
5. Close FastReport.
6. Preview the report to verify that your new template is in fact applied to this report.

Repeat steps 6-13 above for every report where you want your new template applied.

Designing your own reports

The Report Manager uses a report generator tool named FastReport. This is an add-on component which opens inside Condmaster, making it look like an integral part of the Condmaster program. FastReport has the capability to generate reports containing graphs, spectrums and time signals as well as orbit graphs.

FastReport is a complex product requiring a certain level of programming skills and understanding. Along with the Condmaster installation comes a separate user manual for the FastReport software. Please take advantage of that and other FastReport support options if you need to design customized reports.

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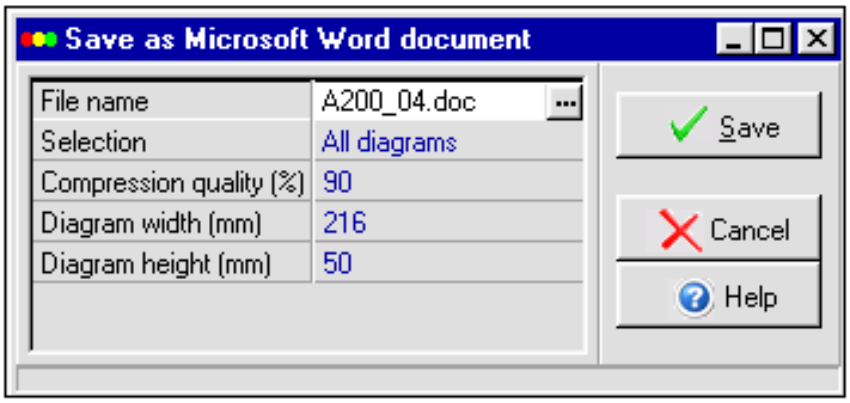
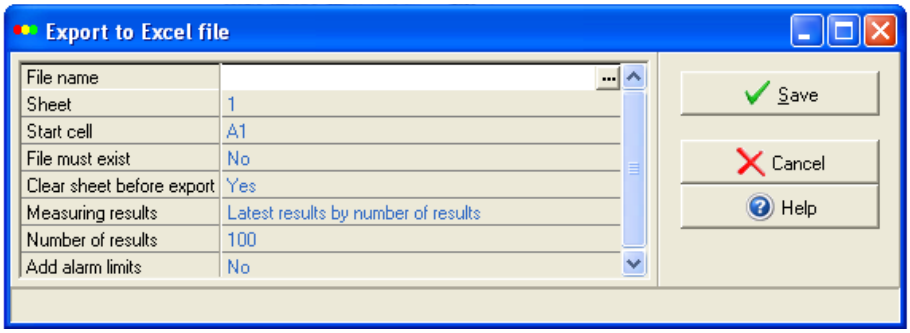


Export to Word file

Clicking the **WORD** button next to the trash bin on the Graphics screen sends the whole or parts of the graphics selection in jpeg format to a Microsoft Word file. On a menu, you can make a selection, edit diagram size and compression quality.



Export of measuring results to Excel

In the Graphical Overview, you can mark any folder or group of folders and click the **EXCEL** button on the top of the screen to export the measuring point name and number and all its measuring results to an Excel document where you can set up your own graphics for the results.

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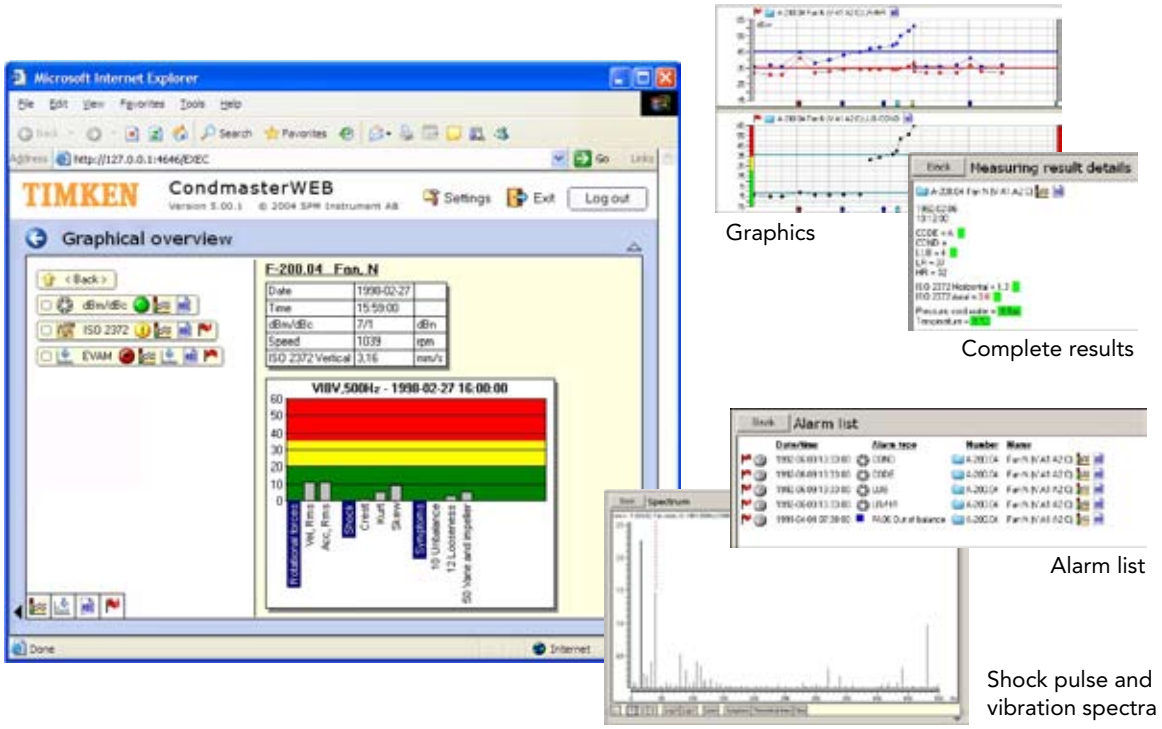

Read only access via Internet

CondmasterWEB

CondmasterWEB is an optional module, allowing the user to reach his Condmaster program as a 'read only' version from any PC running Microsoft Explorer.

Condmaster will open in the Graphical Overview. By clicking on folders and icons, the user can quickly and easily reach any measuring result display and manipulate it in real time in the same way as in the corresponding window of his 'real' Condmaster Nova. Measuring point set-ups can be seen but not edited.

CondmasterWEB installs as a service on the server computer and can be accessed from the client browser via LAN or Internet, normally through port 5790 (default). The server computer requires Windows NT or higher and the client requires Microsoft Explorer 6.0 or higher.

Examples of addressing CondmasterWEB after logging on to the webb with Microsoft Explorer

running on an external computer in the network:	http://(computername):5790/
running on your own computer:	http://localhost:5790/
running on an external server:	http://(servername):5790/

For installation and setup, see "Installation and system administration" 71917B.

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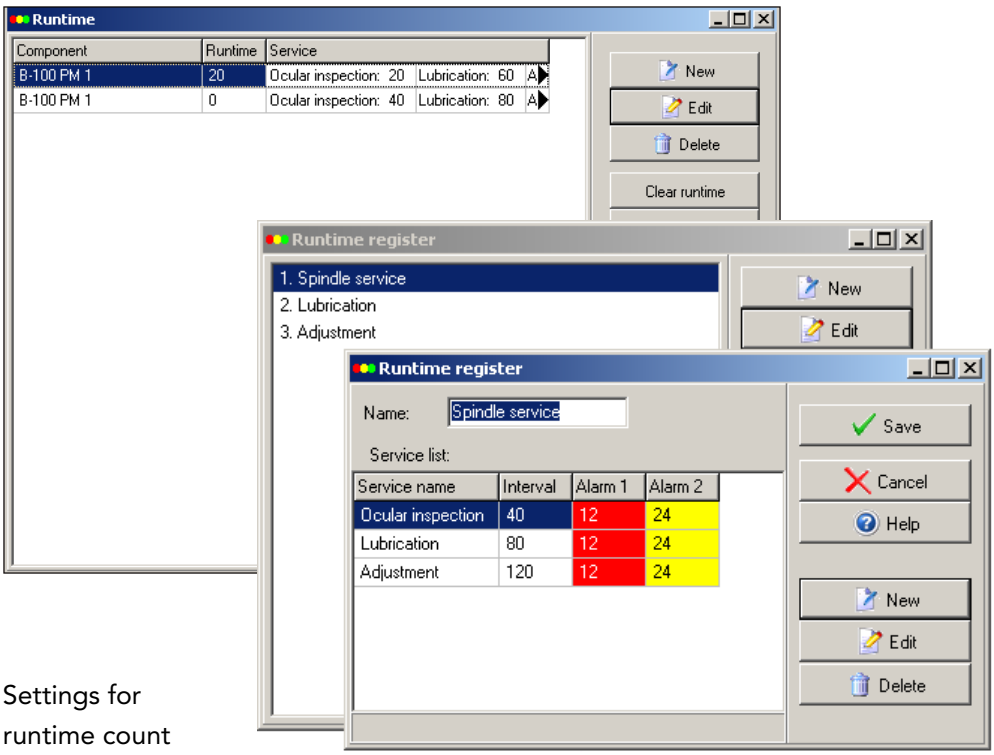

Settings for runtime count

Runtime count

This is an optional function that counts the number of hours a component has been running, and reminds the user when a periodic machine maintenance service is due. Typical services are inspection, lubrication, oil change or part replacements which are due after a stated number of operating hours.

The function is used in connection with continuous monitoring (CMS System). On machines with variable speed, the rpm is used to indicate whether the machine is running or not. Components with fixed rpm must have at least one measuring point with the technique 'User defined measurement'. As an example, it can measure the temperature of a bearing. When a stated minimum value is exceeded at the time of measurement, the machine is 'running', else it is not. The measuring intervals must be short enough to get a realistic estimate of the machine's operating hours.

A short description of the maintenance service is saved as a 'Standard comment'. One or more of these comments are connected with the service assignment, e. g.:

A Inspection (every 40 hours)
B Lubrication (every 80 hours)
C Spindle bearing adjustment (every 120 hours).

By making one service assignment which includes these three jobs, the user starts three clocks which respectively give alarm every 40, 80, and 120 hours. 'Adjustment' includes 'Inspection' and 'Lubrication', so all three clocks are zeroed when 'Adjustment' is reported back as done. 'Lubrication' includes 'Inspection', so two clocks are zeroed while the countdown for 'Adjustment' continues.

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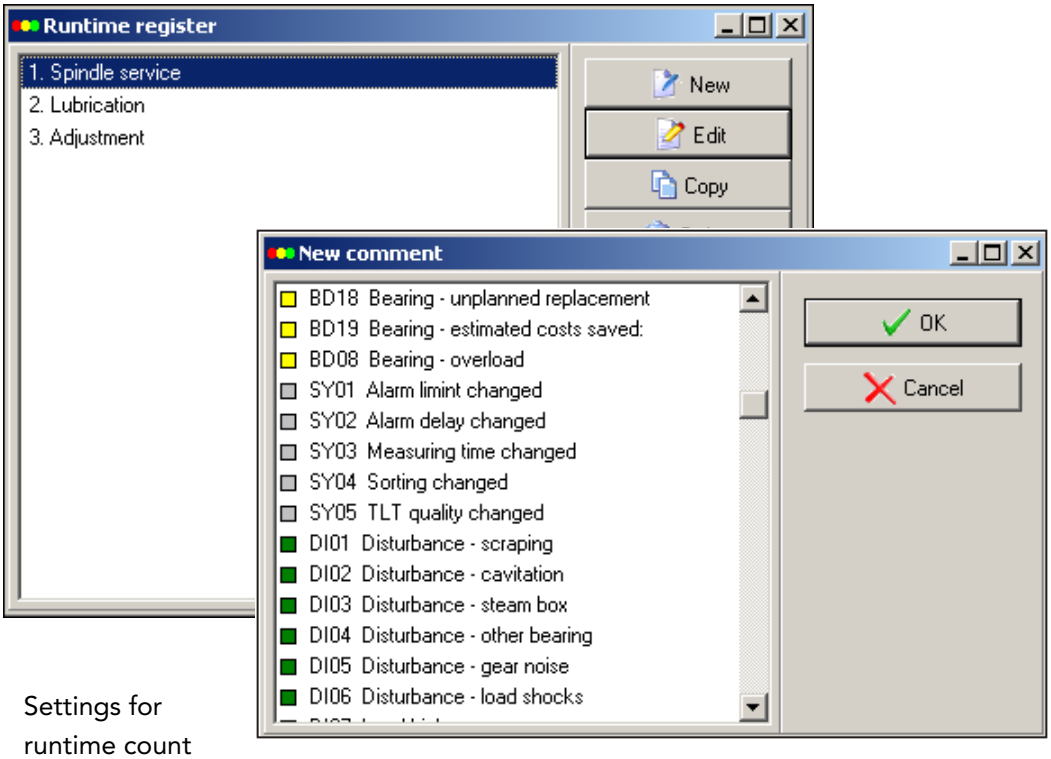

Settings for runtime count

Runtime count

To achieve this,

1. Input all three services on the same runtime form in the runtime register under a common name, e. g. ‘Lathe maintenance’.
2. Input the three comments in the Standard Comment Register.
3. Attach all three comments to all three sub assignments.
4. Designate the appropriate comment as ‘service comment’.
5. Set two alarm times, e.g. yellow alarm 8 hours, red alarm 4 hours before the service is due.
6. Attach this ‘Standard service assignment’ to thecomponent.

It will appear on the runtime form under **Maintenance** in the menu bar, where it shows the hour count.

The service report is made either

- via the button on the runtime form which sets the service comment against the component (visible in the ‘Graphics’ display and on the comment list) and nulls the clock.
- by setting the service comment with the **Set comment** function.

Service alarms connected with the runtime function do not appear on the alarm list. To check what has to be done, open the run time function and check the remaining hours to service. The message will change to alarm color at the stated number of hours before the service is due.

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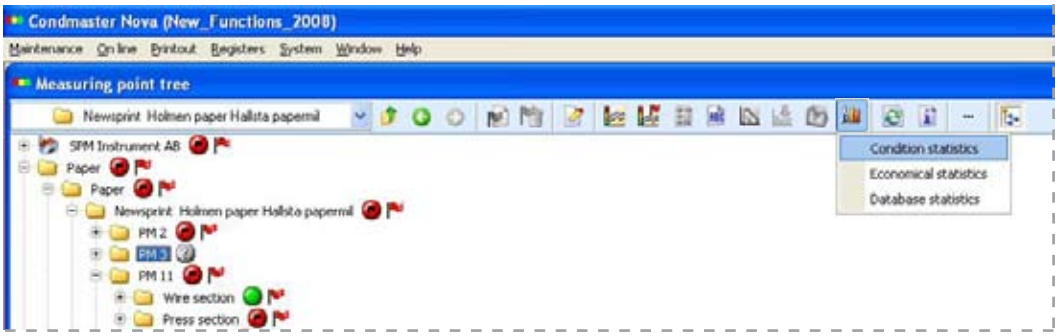
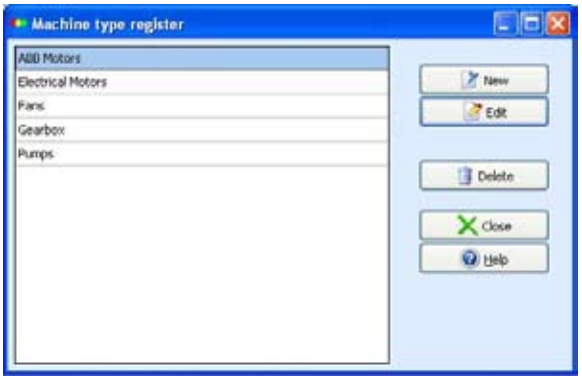
Plant Performer™

Plant Performer is a statistical module which can be used to visualize and evaluate the economical and technical impact of your maintenance program. Statistical assignments are user defined and may include database or machine condition statistics and technical Key Performance Indicators, presented in pie, bar chart or 3D diagrams. Plant Performer is accessible via the **Plant Performer** button in the Condmaster toolbar:

For the sake of economical statistics, the concept of machine types has been introduced in Condmaster. Machine types are created under **Register** > **Machine type register** and then connected to measuring points in



the **Measuring point data** form. When corrective measures have been taken, users enter information in a **Corrective maintenance** comment. Calculation intervals can be specified, and the resulting two or three dimensional graph can be exported to Word or Excel, printed or copied to clipboard. Machine types are also the base for machine condition statistics.



Technical KPIs (Key Performance Indicators) are set up on the measuring point level. KPIs are quantifiable metrics used to facilitate defining and measuring progress towards the goals of the maintenance organization, i.e. the overall vibration level for a department, or an entire plant, calculated on a regular time interval.

The contents of the database, such as the number of measuring points or rounds, can be viewed using the database statistics function.

Economical statistics

Economical statistics in Plant Performer show estimated savings gained by doing corrective maintenance during scheduled stops. Through such planned activities, costs for corrective actions can be minimized, avoiding breakdown of machinery and optimizing productivity. Certain actions will also improve the running condition of the machinery which means longer lifetime.

As estimated savings are difficult to calculate exactly, it is recommended that the savings input in Condmaster are kept on an agreed-upon minimum level. For instance, if everyone agrees that bearing replacement generally saves at least $xx, that is the amount to enter in Condmaster when bearings have been replaced.

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Corrective maintenance comments

Corrective maintenance comments are used to enter the amounts saved through repairs etc. These comments are found under **Comment data**, accessed via the **Comments** button ("**ABC**") in the Condmaster menu bar:

Direct Maintenance Costs

Savings on costs for labor, logistics, rented tools, lifting equipment etc. Repair work done in a planned manner drastically reduces the total time for the replacement. Labor costs are lowered because of less overtime etc. Spare parts can be ordered well in advance at minimum costs. The same goes for special tools, lifting gear, working platforms etc.

Production Time

Estimated time saved by doing corrective actions in a planned manner. Jobs done during planned production stops benefits availability.

Waste production/Reworking cost

When breakdowns or unplanned events occur, product quality will often be negatively affected. The stopping and starting of production processes normally implicate quality losses. Avoiding such stops is money saved.

Loss of Contribution

Estimated savings in increased production through avoiding or shortening a stop. Loss of contribution is calculated as contribution per hour (sales price of the product – production cost). Total savings in LOC is the contribution per hour * the saved time.

Costs for Secondary Damage

When a component can be replaced prior to breakdown, secondary damage on other components such as shaft, bearing housing, gears, impellers etc. can be avoided.

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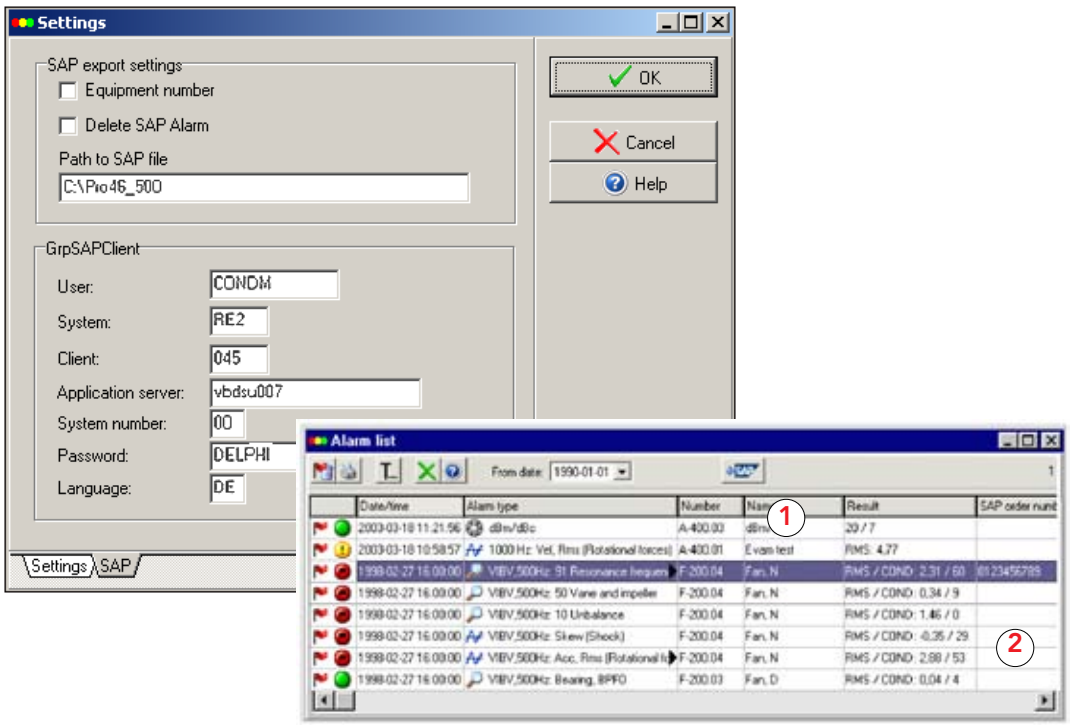

Communication with SAP software

Timkens software Condmaster Nova for machine condition monitoring now provides a direct link to SAP software. Pressing the **SAP** button (1) on the Condmaster alarm list sends the marked alarm message to the SAP software. Returned is a SAP work order number (2) that locks the alarm, until a second message from SAP deletes the alarm and sets a comment against the Condmaster measuring point, stating what has been done.

In addition, the Condmaster measuring point setup now contains an optional field for SAP equipment numbers.

The operation requires no extra data input and one simple operator decision: Does the Condmaster alarm merit an SAP work order? The SAP operator responds by sending a Standard Comment to a text file.

Standard Comments are a user defined register of short messages in Condmaster, e. g. ‘Bearing replaced’. The SAP operator can add free text. On receiving the comment, Condmaster deletes the alarm. The comment is added to the list of comments under the measuring point and is visible in the measuring result diagram.

- When Condmaster is set up, the SAP operator is registered in the window shown above. For SAP protocol, see “Installation and system administration” 71917B.

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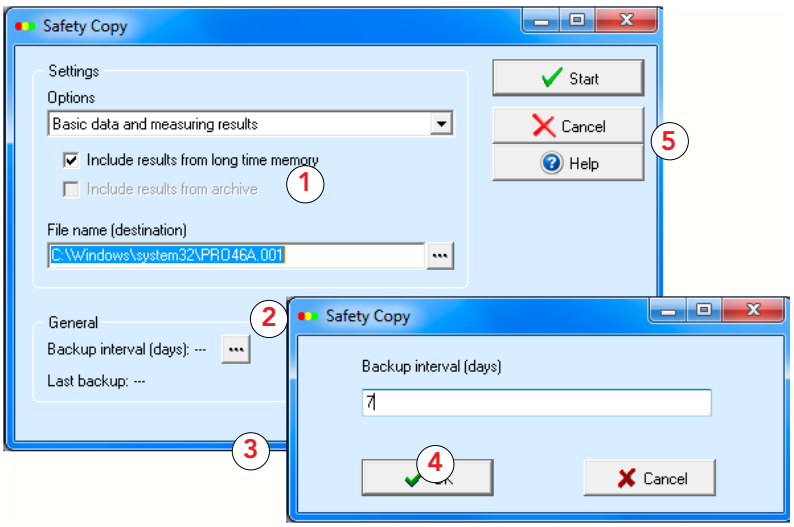

Safety copy:

- Select data type (1), normally **Basic data and measuring results**
- Type the path to destination drive (2)
- Press button (3) to set the interval (4) for automatic reminder
- Click **START** (5)

Safety copy

Make safety copies on **two** memory units. An unit can fail, and you do not want to lose any of your data. You can, of course, copy to a hard disk – but do not copy to the same disk that holds your Condmaster Nova database!

- Exit all programs except Condmaster Nova.
- Pull down the menu under **Window** (top of the screen) and select **Close all windows**.
- Pull down the menu under **System** (top of the screen) and select **Safety copy**.
- Follow the instructions on the screen.

Normally you mark **Basic data and measuring results** on the safety copy form, which means everything will be copied. You can also keep **Basic data** (Condmaster Nova settings, machines, measuring points) and measuring results on separate disks. It is also possible to make safety copies of the bearing catalogue only or all reports for printout.

On the safety copy form, you can set a time interval for safety copies. You will get a reminder to make one when you start Condmaster Nova.

The safety copy is a compressed file with the suggested name Pro46a.001 (002, etc., depending on the number of memory units). You may change the name, but not the file extension (“001”,”002” etc). In case of trouble with your hard disk, use **Reload safety copy** to restore your data. Please note that this is for emergencies: you lose all data which have been stored in Condmaster Nova between the making of the safety copy and the reloading time. Safety copies made with older program versions are not compatible, so make new safety copies after each program update.

After the copy has been made, old data can be deleted. Select data type (e. g. measuring results) and enter a **Prior to** date.

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